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ENGINEERING AND

Mining Journal

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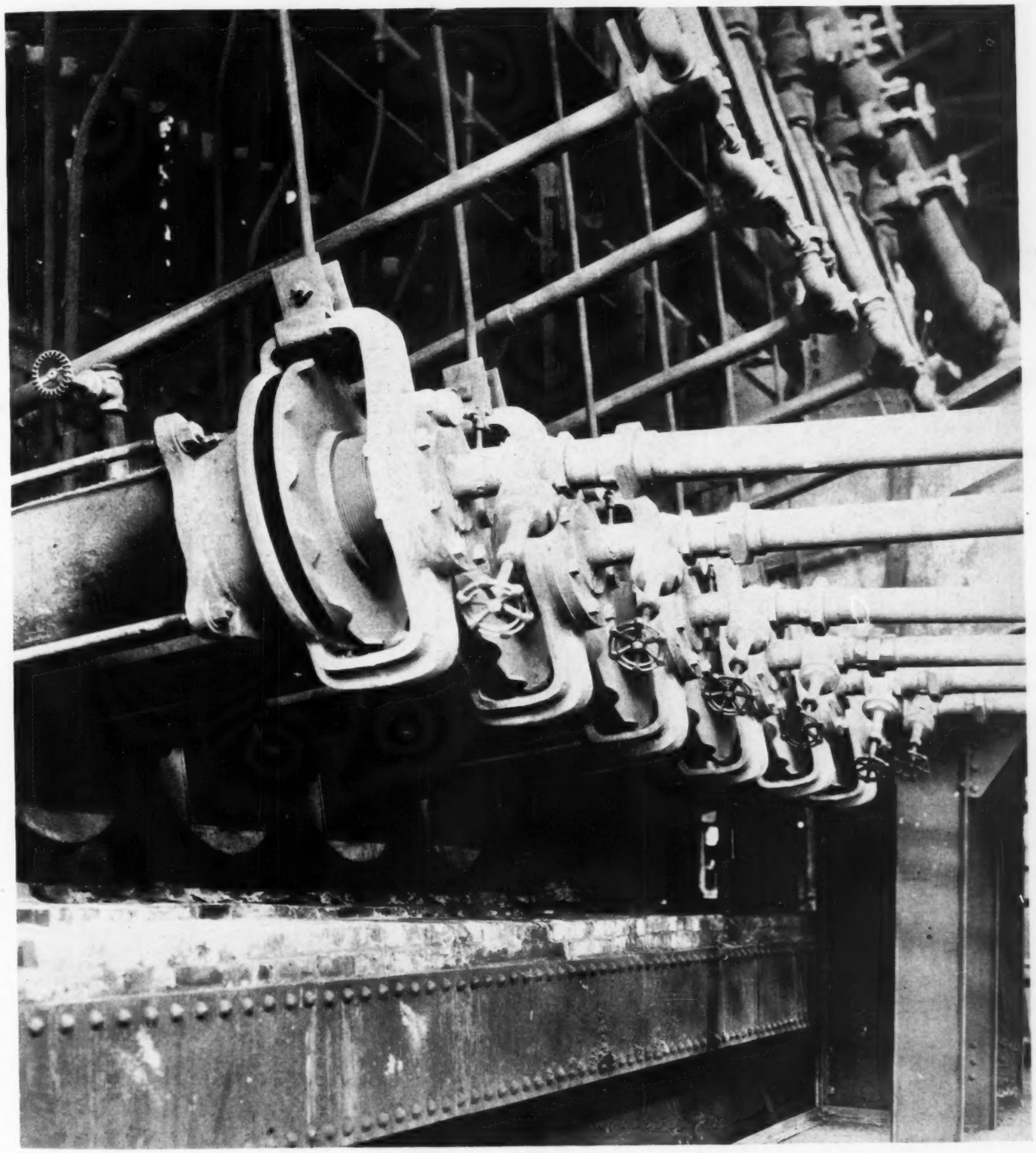

Natural-gas burners for the reverberatory at the El Paso smelter

June 7, 1930

Chromium Corporation Uses Portable Compressor For Exploration and Development Work

The Chromium Corporation has recently been engaged in exploring a deposit of chrome ore, located in the southwestern part of Montana. The mining equipment used during preliminary operations included an Ingersoll-Rand 10″ x 8″ portable compressor, a No. 34 drill steel sharpener, a 6F oil furnace, and two S-49 "Jackhamer" drills.

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At top: one view of the chromium mining camp (elevation, 8,000 feet)

At left: the I-R compressor on its way to the workings. Because of the heavy snowfall, it was necessary to haul the compressor on skids for more than 3 miles

252-PC

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Contents for June 7, 1930

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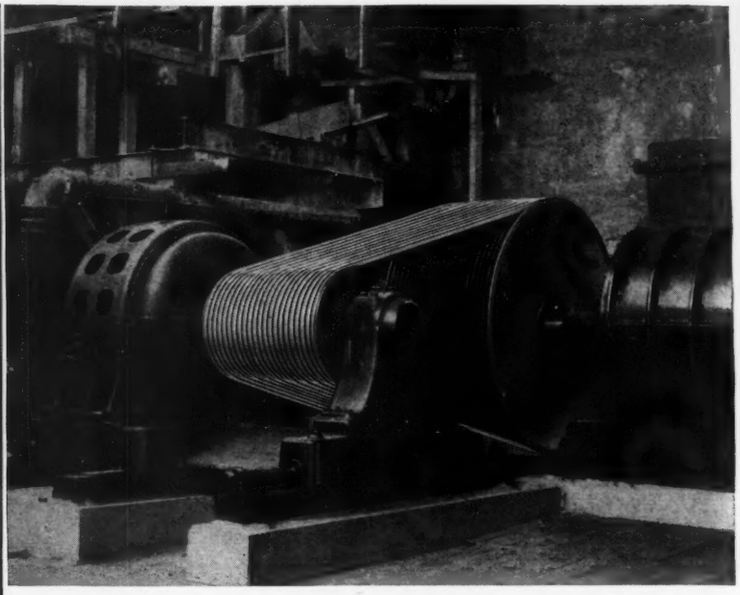

The illustration shows a 350 H. P. Texrope Drive operating a blower in the plant of the Cananea Consolidated Copper Co., Cananea, Mexico. Texrope Drives are used throughout the mining industry.

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ENGINEERING AND
MINING
JOURNAL

A. W. ALLEN, *Editor*

VOLUME 129, No. 11

ESTABLISHED 1866

New York, June 7, 1930

Mining Claims in National Forests

PROBABLY the cause of the movement to restrict the rights of locators of mining claims and the owners of patents thereon within the National Forests, as expressed in Senate Bill S-3774, which has passed the United States Senate and has been referred to the House of Representatives, may be found in a decision by the District Court of Idaho, N. D., of February 11, 1928, which fully confirmed the rights of the locators of mining claims, as allocated by the existing mining laws, as covering the locations within the National Forests.

Since then a movement to curtail those rights within the National Forests has started, and the United States has passed Bill S-3774, above mentioned, restricting those rights very severely in South Dakota; and we understand that a similar bill, curtailing the rights of mineral locators within the National Forests of the State of California, will be introduced in Congress, at the insistence of the Forest Service, unless a decided opposition by the mining interests of California should prevent this action.

Senate bill 3774 places the owners of mining locations and of patented mining locations within the National Forest at the mercy of the Forest Service. Rights are controlled by the term "reasonable." For instance ". . . . the right to occupy and use the surface as may be 'reasonably' necessary to carry on mining" . . . "no use of the surface of the claim or the resources therefrom not 'reasonably' required for carrying on mining shall be allowed." It is repeatedly stipulated that operations shall be under the National Forest rules and regulations. As no provision is made in the law stipulating what authority is to decide what the term "reasonably" covers, this decision is in fact left entirely to the rangers, who are not competent judges of the requisites of mining operations.

When starting the development of a mining project it is impossible to foresee what resources of the surface will have to be used. In nearly all instances water is required. According to the wording of the law under consideration, the locator is at the mercy of the Forest Service in respect to this important resource.

The application of the rules and regulations stipulated by this law will prevent any practical mining man from starting mining operations within the limits of the National Forests, thus stopping the development of new mineral resources within these reserves. The mineral products of the country are of far greater value than the forest products. Their development, as a general rule, will only slightly impair the development of forest products.

Apparently the sponsors of this bill intend to introduce its system through the entire United States. It is most important for those vitally interested in mining activity to take steps to prevent, if possible, any further move to curtail the rights of the locators of mining claims.

Gospel of Simplified Practice Continues Its Winning Way

FEATHERS for the cap of the United States Department of Commerce continue to accumulate, until that figurative toppiece begins to suggest an Indian headdress. When Mr. Hoover, as Secretary of the Department, set out to reduce the unnecessary complexities of industrial practice, he undertook a colossal task. The orderly success achieved and the quiet progress indicate how well the plan was conceived and how capably it has been managed.

Up to a year ago recommendations as to simplification covering ninety different commodities had been adopted by representatives of manufacturers, distributors, and users at conferences held under the Department's auspices. Since then the number has increased. The latest addition to the list has been diamond core-drill fittings. New standards will govern the manufacture of such fittings as from May 1, 1930. Their purpose is to make the bits, casings, rods, and related parts, wherever manufactured, interchangeable so far as controlling diameters, threads, and dimensions of joints are concerned, and to provide a series of casings of such size that they can be nested. This series will permit three reductions in diameter of hole below three inches. To insure such interchangeability, manufacture will be conducted only with standard working gages supplied by the newly organized Diamond Core Drill Manufacturers' Association, the history and activities of which were given in the May 8 issue of *Engineering and Mining Journal*.

The benefits to be derived from such standardization are obvious. They will be greater to contractors and other users than to the manufacturers, as a moment's thought will show. Compared with many other lines of equipment, core drills are produced on a small scale, the few drills of one contractor sufficing to meet the prospecting needs of several mining or construction companies. Nevertheless, another step is achieved in simplifying complex practice. In the aggregate, an appreciable saving should result.

The "Money-Minded" and Research in Pure Science

THAT a fair return is accruing to the public as a result of scientific endeavor in this country is commonly accepted as fact, particularly in recent years when announcements of new technical achievements have followed one another with amazing rapidity. This viewpoint, although popular, suffers on investigation. In the May number of *Atlantic Monthly,* Mr. T. Swann Harding states that, owing to the control that commerce and industry exercise over scientific research, the public is being deprived of knowledge, power, and wealth to which it is justly entitled. Anent this contention, Mr. Harding points out that, although $25 is spent for research per $10,000 of national annual income, $22.50 of this amount is used for practical investigations, and only $2.50 for fundamental research in pure science—that is, for the acquisition of information on which civilization builds.

The conclusion expressed by Mr. Harding is not new; it is common knowledge among scientists, and has been discussed at length in the technical press and elsewhere. Nevertheless, the situation remains, and it becomes increasingly evident that the intense endeavor to adapt discoveries of the past to present-day needs is preventing the building up of adequate reserves of scientific knowledge. The progress of mining, along with that of other industries, has been retarded as a result of the emphasis placed on the purely commercial phases of research endeavor. A striking instance of this, one which is not generally known, although associated with a major development in the mining industry, may be retold here:

For the greater part of the latter half of the nineteenth century it was well known that gold was soluble in a solution of potassium or sodium cyanide. Some scientific research was done; but because the investigations lacked official encouragement or material assistance the work stopped at the first stage, and little attempt was made to discover or evolve a process for recovering the gold from the cyanide solution after it had been dissolved, or to ascertain if this first step in treatment could be accomplished without prohibitive expense—that is, with weak solutions. A syndicate of engineers, among whom was John Stewart MacArthur, made experiments in 1886 in an effort to discover such a process, and their investigations led to what may be termed one of the notable inventions of the century. In all their tests, however, success was gaged by a consideration as to whether or no actual gold could be produced by the method adopted—the gold had to be laid "on the table"—and neglect to appraise the real value of theoretical research resulted in faulty judgment and much delay. Various solvents, of a dilution indicating commercial practicability, were tried on the gold ore; and an evil-smelling gas—sulphuretted hydrogen—was used to precipitate the precious metal from the solutions resulting.

With weak cyanide solutions there was no result—no gold was precipitated—and the experiment was voted a failure. As a matter of fact, however, the first stage of a new process had been completely successful. But practical commercial results were being sought, as they invariably are in all industrial research, and a scientific fact of vast importance passed unnoticed and unrecorded. Nearly a year later an accidental discovery was made of the absence of gold in the residue from the original test; and it was then realized that the failure to lay the gold "on the table" was due to the fact that the precipitant used—the sulphuretted hydrogen gas—was ineffective. Further tests then confirmed the conclusion that the gold had been readily dissolved in the first instance by means of a dilute solution—a feasible step from the commercial standpoint. Had the haste of commercialism been replaced by the thoroughness of science the discovery of the cyanide process would undoubtedly have taken place a year earlier. But for an accident it might have been delayed for a decade or more, with economic consequences impossible to estimate.

Apparently little change in attitude toward pure science has taken place since the 'eighties, for Mr. Harding describes in his article several experiences similar to the foregoing that have occurred in the last few years. He calls on the "one hundred thousand scientific workers of sorts" to remedy the situation—if it is to be remedied—believing, evidently, that suitable encouragement, sympathy, and facilities cannot be expected from the "money-minded." However, the future of commerce and industry is so closely allied with and foreshadowed by the achievements of pure science that a prolonged continuation of the conditions referred to by Mr. Harding seems improbable.

If the perspicacity and vision commonly attributed to the leaders in the business world are not figments of the imagination, these leaders must soon recognize that in pure scientific research they have the best insurance for the future. When this is understood, the scientist, the "money-minded," and the public will share jointly in the benefits that the vastly increased number of new discoveries would be certain to bring.

Production Costs in Rhodesia Still Largely Problematical

"CHEAP, breechclout copper" is the picturesque phrase applied by a Western newspaper to the potential production of Northern Rhodesia. Unquestionably this is the attitude of many observers of the copper market. Low-grade copper mines in the United States and Canada will be hard hit when the immense amount of copper that will come from the heart of Africa is added to world supplies, they feel. Because colored labor is cheap, because the reserves of ore are large and—compared with American mines—relatively high grade, they assume that Rhodesian copper will be low-cost copper.

This attitude is not shared by all engineers conversant with the situation in Rhodesia. A large water flow underground, inefficient and possibly insufficient labor, lack of local timber supply, and a long haul to market—such factors may do much to keep costs at a relatively high level. One engineer who has recently visited Rhodesia suggests that a comparison of the new mines with Bwana M'Kubwa's operating Bwana mine may shed some light on probable costs. Bwana's operating profits, even with the higher copper prices of 1929, have been small. In fact, the operation recorded its first profits in July, 1929, although production with the present plant was started in 1926. With copper selling at about £72 per long ton, the company made a profit of £5,000 in that month, or at the rate of £60,000

a year on a production of about 6,500 long tons a year, making operating costs roughly £62 per long ton, or between 13 and 14 cents a pound for unrefined copper. Bwana markets standard copper, whereas some of the new mines may have to refine their blister.

Furthermore, the new underground mines can hardly hope to operate for less than at Bwana, where the ore is mined by open-pit methods and the difficult problems of timbering and water control are not met. On the other hand, because it treats an oxidized ore, Bwana has had metallurgical difficulties that the sulphide mines may not encounter. The other mines will also operate on a larger scale. By the time they are in production, some reduction in freight rates may be expected. The grade of ore at Bwana is about 3.5 per cent, compared with 3.3 per cent at Roan, 4 per cent at N'Kana, and 4.5 per cent at Mufulira.

So many uncertain factors enter into the question of costs at the Rhodesian copper mines that calculations should be regarded as tentative until production is started. Whether Rhodesian copper will cost little or much to produce remains to be seen, but *Engineering and Mining Journal* sees no reason why low-grade operators in the Western hemisphere should view the future with trepidation. Rhodesian production will probably be neither large enough nor sufficiently cheaply produced to disrupt the copper market, certainly not within the next five or ten years.

"What Is Not Yet May Be"

THE American Society of Mechanical Engineers, in choosing these words for an inscription on the medal commemorating the fiftieth anniversary of the founding of the society, has unconsciously defined engineering. Although it is considered as the art of making nature subservient to man, engineering is in a continual state of change. By instinct and by education the true engineer is an iconoclast; but, fortunately, his radicalism is tempered by, or rather based on, constructive inclination, not on unreasonable dissatisfaction with present conditions. He tears down only to build up. New branches of engineering arise in this process of development. And mining, hoary and venerable with age, serves old and new members of the family with a fine efficiency and impartiality.

Superficial observers sometimes express the apprehension, as human knowledge increases, that no problem will be left for future generations to solve. The thoughtful observer, however, soon realizes that, as the border line between the known and the unknown is pushed back, its dimensions increase—even as the ripple from a pebble thrown on water extends as it moves away from the point of impact. Opportunities for the pioneer will always abound.

Many persons who deplore the growing mechanization of the age recall the happiness of the simple existence of bygone days, glorified in the deceptive light of tradition and memory. But is not the modern greyhound of the Atlantic as beautiful as was the old clipper? Is the power forge less romantic than was the anvil of the village smith under his spreading tree? And does not the evening sky hold even more mystery to an observer at Mount Wilson than it did to Copernicus or to the Chaldean star-gazers? The future promises more romance than did the past.

Engineering in itself is not the end. It does not profess to be; but it should be, and is, a means to improved human happiness. And the fact that obstacles and limitations are constantly being overcome should constitute proof—perhaps the only proof—that man's capacity is infinite.

A Good Reputation Must Be Guarded

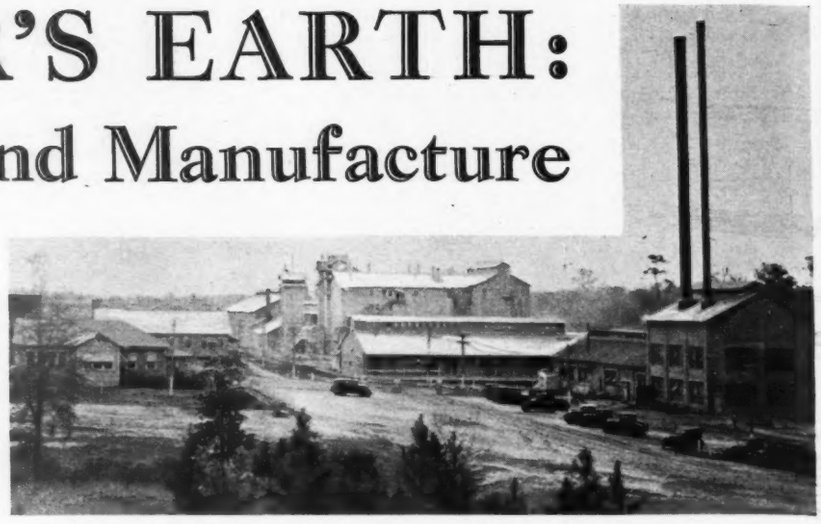
THE decision of the American Zinc Institute to refrain from premature promotion and publicity in connection with research to create new uses for zinc deserves commendation. New products should conclusively prove their merit before they are offered to the public. Early producers of die-cast zinc had a sad experience before this lesson was learned. Seasonal cracking and mechanical defects, developed after the products had been put on the market, gave the industry a serious setback, and many years of hard work were required to regain the ground that was lost. Incidentally, a high type of metallographic research was needed to determine causes for the early failures. It allowed the industry to establish itself on a solid basis. The manufacturers are sure of their products and can state definitely what customers may expect from them. Recent developments in the production of high-grade zinc have also been a great aid to the die-casters, placing within their reach at a reasonable price a raw material with uniform qualities and with physical characteristics far superior to those of the impure zinc used in the early stages of die-casting.

In this connection another problem presents itself: The requirements in regard to quality and purity of the commercial metals have been so high that the metallurgist has had to maintain a constant vigilance to keep from falling below standard. In late years an increasing production of electrolytic metals has raised the standards to a degree previously attained only in the laboratory. The manufacturers, however, have not always shown similar interest in maintaining the same high standard. One producer of a non-ferrous metal, who took pride in a product almost free from iron, received a complaint that certain articles made from his metal were unsatisfactory. The content of iron was too high. Investigation revealed the fact that the iron had been introduced by careless manipulation in the manufacturing process. Some galvanizers, unfortunately, have applied the zinc coating only to present an appearance, not to protect the baser metal. And some of the nickel plating done at the present time is of such poor quality that the uninformed may well doubt the merit of that process.

Producers of metals should consider these facts. They should, whenever possible, extend an influence over their metal until it reaches the ultimate consumer. A good reputation is worth preserving. It is too valuable an asset to be intrusted to those who may endanger it by carelessness and neglect.

FULLER'S EARTH:
Its Mining and Manufacture

H. D. Keiser
Assistant Editor



General view of the plant of the Attapulgus Clay Company

FULLER'S EARTH, which was first used for "fulling" or removing grease from woolen goods and from which process it was named, is a variety of clay that has the property of removing basic colors from solution in animal, vegetable, and mineral oils. Petroleum refiners are the largest consumers of fuller's earth.

At Attapulgus, in Decatur County, Ga., the Attapulgus Clay Company, owned by the Atlantic Refining Company and the Standard Oil Company of New Jersey, has been mining fuller's earth since 1920 from a tract of several thousand acres. Operations of the Attapulgus company have trebled since their inception, and at the current rate of production the deposit has an estimated life of 40 to 50 years.

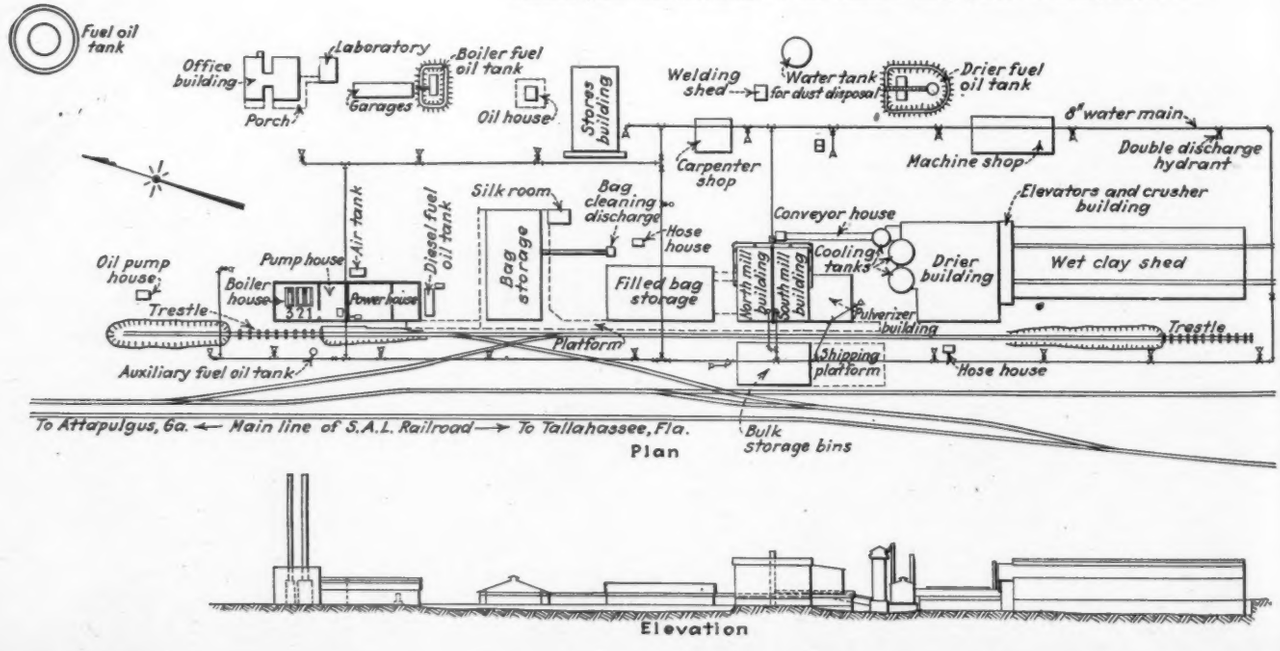
The thickness of the deposit varies from 2 to 12 ft., averaging about 7 ft. Overburden ranges in thickness from a few to 50 ft. and averages about 35 ft. Open-cut mining methods are employed. Overburden removal, for safety and convenience of operations, is kept at least six months in advance of actual mining of the deposit. In the removal of overburden, a layer, 1 to 3 ft. thick, is left in place to protect the underlying clay from deterioration that results if the clay be permitted to weather.

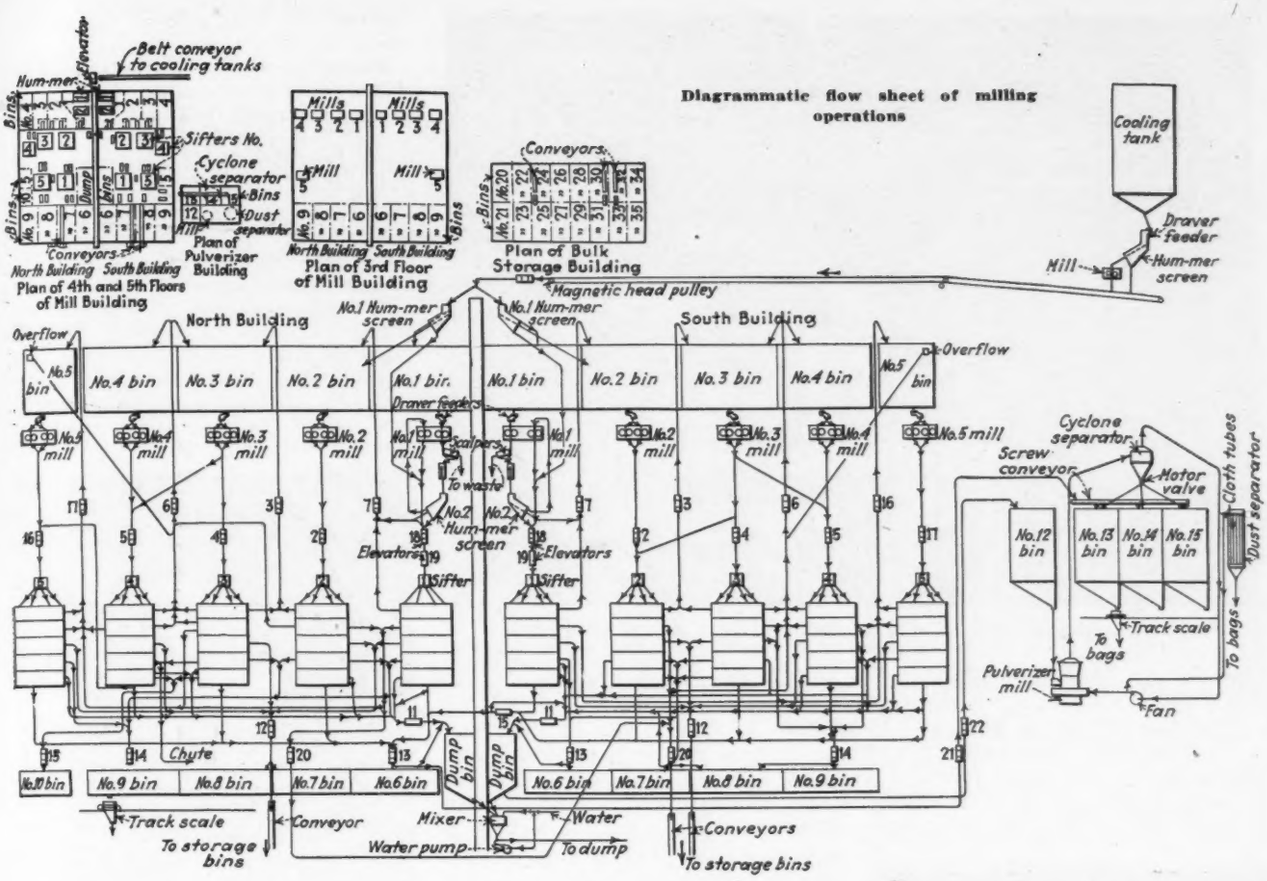
When a pit is opened, a cut is made through the overburden with small dipper- or drag-type steam shovels. Removal of the overburden is then continued with 75- to 90-ton standard-gage steam shovels of the railroad type, equipped with 2½- to 3½-yd. dippers. Marion, Bucyrus, and Osgood steam shovels are used. Overburden is loaded by the steam shovels into 12-cu.yd. standard-gage cars, which are moved to a dump by 60-ton steam locomotives. The dump is usually situated not more than a mile from the pit, and is formed by first constructing a temporary trestle about 40 ft. high, from which the cars of overburden are dumped. When the overburden material reaches the top of the trestle, the dumping track is moved laterally on the material, a fan-like shape being given to the dump as it is built up.

In mining the clay deposit, the protective layer of overburden is first removed, and the bank dynamited. This use of explosives makes the clay easy to handle and imparts to it an initial fracture that is desirable in subsequent treatment operations. In dynamiting, the practice is to drill a series of holes, 3 in. in diameter and 8 ft. apart, immediately ahead of steam-shovel operations. The amount of dynamite used varies with the thickness and hardness of the clay, the average charge being about 1½ lb. per hole.

The clay is loaded into 5-cu.yd. side-dump cars by means of Thew and Marion steam shovels, equipped with ⅝- to 1¼-yd. dippers and caterpillar

General plan and elevation of the fuller's earth plant at Attapulgus, Ga.





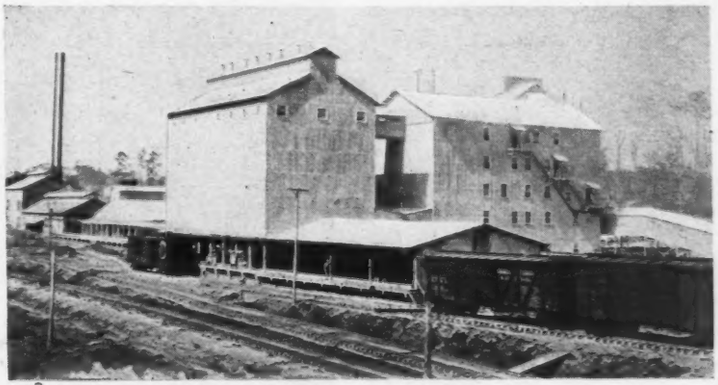
treads. Steam shovels of this small size are employed because of the shallow depth of the clay, and because a clean cut at the bottom of the deposit can be made with them. The comparative hardness of a sandstone that usually underlies the clay permits nearly all of the clay to be scraped up by the dippers of the steam shovels, without danger of contamination. Trains of 15 to 25 cars are hauled from the pit by small steam locomotives over a 36-in. gage line to the wet clay shed, where the clay, ranging in size from a fraction of an inch to 10 in., is dumped onto a drying floor. The locomotives weigh 21 to 30 tons and are of Porter, Baldwin, and Davenport manufacture.

The wet clay shed has a capacity of 3,000 tons. It is 250 ft. long by 50 ft. wide, has lattice sides, and a storage depth of 15 ft. below the track level. After the clay has been air-dried for two or three days, ¼-yd. orange-peel buckets, operated from two traveling electric cranes, load it into two distributors, as shown in one of the accompanying illustrations. The following motors are employed for each bucket-crane operation: Dead line, 5 hp.; closing line, 15 hp.; carriage, 5 hp.; crane, 22 hp.

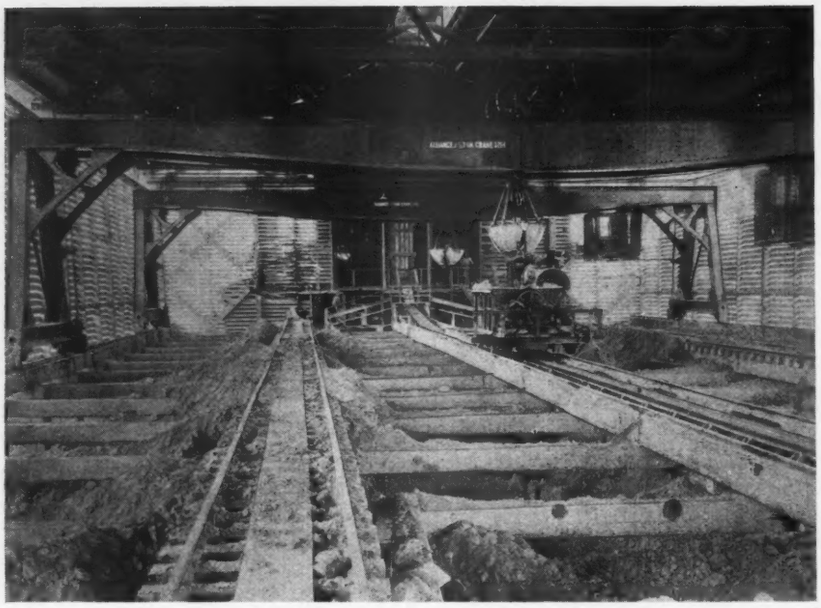
The distributors are portable. Each is equipped with a hopper bottom and a steel-plate apron conveyor, operated by an individual 10-hp. motor. The clay is fed at a uniform rate by the distributors onto a 24-in. inclined belt conveyor that discharges in equal portions into two or more roller crushers, operated by individual 20-hp. motors. These crushers, which are the company's own design, reduce the clay to a maximum size of 2 in.

From the primary roller crushers, the clay passes to bucket elevators that discharge it equally among five secondary crushers, operated by individual 10- to 15-hp. motors. These crushers, which reduce the clay to a maximum size of 1 in., are manufactured by Bauer Brothers Company, and are equipped with specially designed manganese-steel disks that, despite their relatively high first cost, have proved to be economical.

A kiln-type oil-fired rotary drier, 50 to 60 ft. long and 6 to 7 ft. in diameter, and operated by an individual 20- to 30-hp. motor, follows each set of crushers. These driers are housed in an adjoining drier building. The clay, in passing through a drier, is lifted by longitudinal interior channel irons and dropped through the hot gases present. In the twenty minutes required for the clay to pass through a drier, its volatile content, including moisture, is reduced from 40 to 50 per cent to a maximum of 20 per cent. Chain drag conveyors of the bucket type move the product of the driers to three hot rock cooling tanks. These tanks are stationary, steel, vertical cylinders; two of them are 28 ft. in diameter and 23½ ft. high, the other being 19 ft. in diameter and 47 ft. high. The tanks are well ventilated to carry off suspended dust,

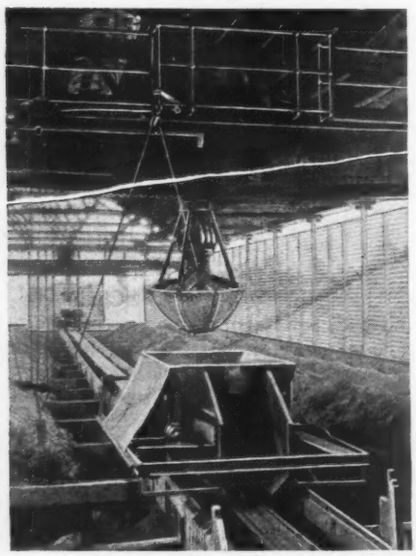


The bulk storage building and one side of the car-loading platform. To the right is the mill building.



The wet clay shed, where the fuller's earth is air-dried prior to being milled

heat, and moisture. By means of chain bucket elevators, the clay is first discharged into the top of the two tanks of larger diameter. Through a series of feed-regulating gate valves in the bottom of these tanks, it passes onto a 24-in. conveyor belt, discharging into a chain

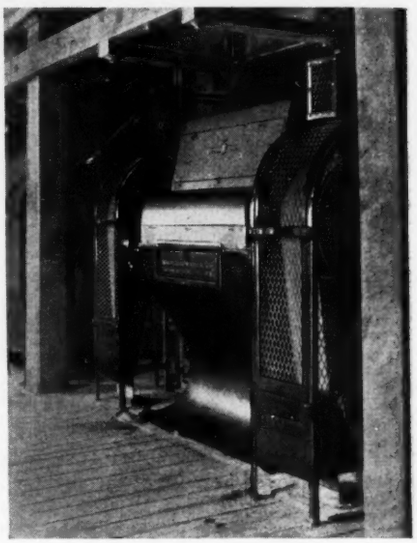


Loading a distributor in the wet clay shed

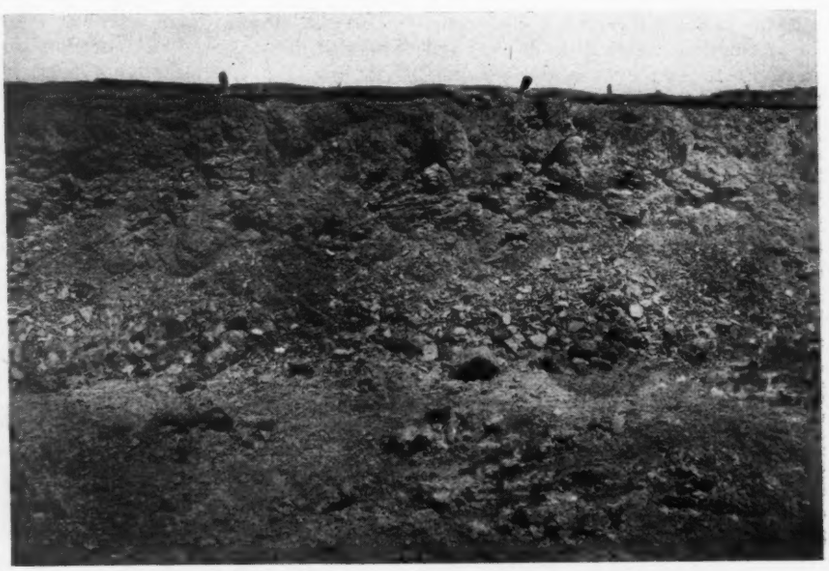
bucket elevator, which in turn discharges into the top of the third tank, 47 ft. high. This tank is equipped with a hopper bottom and a mechanical Draver feeder, through which a uniform quantity of clay is fed to a ½-in.-mesh electrically vibrated Hum-mer screen. The oversize, after being reduced in a high-speed Allis-Chalmers roller mill, joins the undersize, and passes directly to an 18-in. belt conveyor, equipped with a magnetic head pulley that removes all tramp iron. The clay is then taken to the top of the mill building by a bucket elevator of the belt type, and passes in two equal streams on each side of a fire wall that is built on the center line of the building. Operations on each side of the wall are identical but distinctly separate from each other. The initial separation in the mill building is made by a Hum-mer screen of the same type employed under the hot rock cooling tank. Reduction is effected in roller mills that consist of duplicate sets of corrugated rolls, varying in size from 9x30 in. to 10x42 in., and operated by individual 15- to 25-hp. motors. From each set of rolls the material is conducted to a silk-dressed gyrating sifter, operated by a 5-hp. motor. The oversize or tailing from each sifter passes directly to another set of rolls for further reduction and screening. This operation, as shown in the accompanying diagrammatic flow sheet, continues until the material has been reduced to the required mesh.

Milling practice is, in general, similar to that employed in milling wheat. The object of gradual reduction is to limit as much as possible the percentage of fine grades, the principal market demand being for the coarser or granular grades. Hand-made silk of Swiss manufacture is used in the gyrating sifters. It is exceptionally uniform in quality, durable, and can be repaired readily.

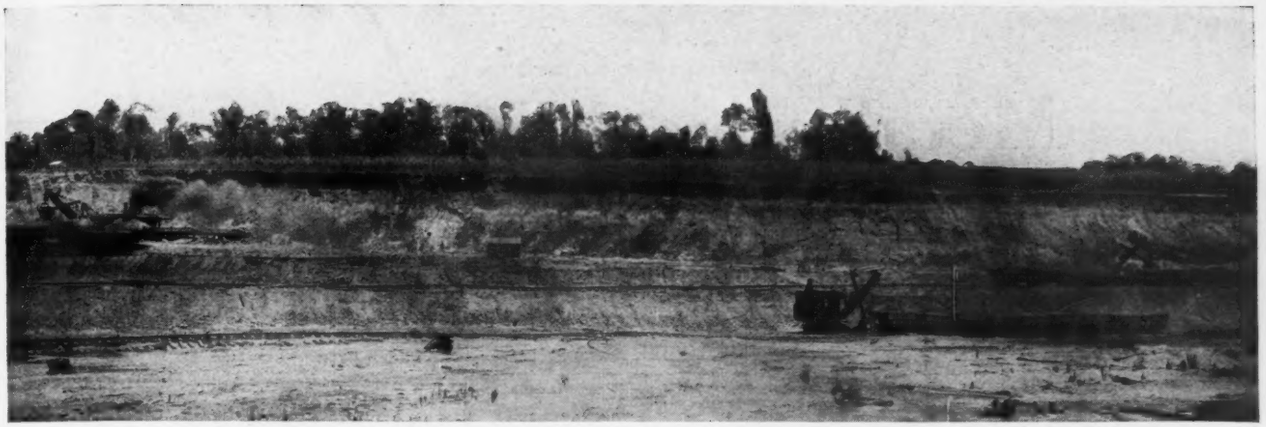
After being screened, the clay passes to a series of bins, in which the various individual sizes of clay are stored. The grade of clay most in demand is transported by belt conveyor to an adjoining bulk storage building, where it is discharged from the conveyor into bins of 75 tons' capacity. Sixteen bins in this building afford a total storage capacity of 1,200 tons. The other grades are stored in a series of bins situated in



A roller mill installation in the mill building



A section of the fuller's earth deposit, with overburden removed



Part of the Attapulgus Clay Company's fuller's earth mine. The two steam shovels on the upper bench are excavating overburden. The lower steam shovel is loading fuller's earth.

the mill building, each bin having a capacity of 75 tons. All bins are equipped with hopper bottoms. Shipments are made in bags and in bulk.

In preparing bag shipments, clay is discharged from the bin hopper into a Richardson automatic scale that weighs out the amount of clay necessary to fill one bag—usually 135 lb. The burlap bag, into which the scale discharges, is made of the highest quality burlap, each bag weighing 2 to 2½ lb. After the bags are filled, they are sewed shut, tagged, and transported by hand truck to the shipping platform. Grain-type freight cars are used for both bag and bulk shipments. In making bag shipments, 25 to 35 tons is loaded per car, the bags being placed with the long dimension horizontal. Bags are the property of the producer, and are credited on the consumer's account when they are returned in good condition.

In making bulk shipments, the clay discharges from the bulk storage bins into a large Richardson automatic scale that weighs out 300 lb. at a time, and is capable of operating at the rate of four weighings per minute. From the hopper of the scale, the clay passes to a Stephens-Adamson portable belt conveyor of the Unicon type. This conveyor, which is an 18-in. by 20-ft. unit, is driven by a 2-hp. 1,200-r.p.m. motor. Construction of the conveyor includes a self-locking hoisting mechanism and ball or roller bearings throughout. The clay is discharged by the conveyor onto a portable loader which is placed inside the car to be loaded. This loader, made by the Ottumwa Box Car Loader Company, is known as a fuller's earth type. It is operated by a 3-hp. motor, and is equipped with a high-speed 18-in. belt. The clay is distributed evenly in the car by the loader, which may be moved readily and adjusted vertically over a wide range.

In selecting railroad box cars for bulk loading, care is taken to obtain cars that are in sound condition. The sides and floor of each car are covered with heavy paper, and false doors are installed inside the doors of the car. Bulk loading is an innovation in the industry, having been in use but little more than a year. It is rapidly growing in favor among both producers and consumers, most of the advantages involved accruing to the latter. The principal advantages are: No labor costs for handling and emptying bags; charges made for bags that accumulate are avoided, as well as the costs involved in preparing bags for return shipment; the freight expense of shipping bags back and forth is saved. Bulk shipments must of necessity be restricted to all-rail transport.

The milling, crushing, and drying departments of the Attapulgus plant operate 24 hours a day, and the bagging and shipping department 10 hours. More than 400 men are employed at the plant.

A complete system of water mains, with connections to numerous double-discharge hydrants, is available for fire-fighting purposes. High-pressure steam and electric pumps are employed. Many portable chemical extinguishers and water barrels have been installed throughout the plant and on the floors of all buildings. Inspection of all fire-fighting equipment is made at frequent intervals, and a well-organized fire department is maintained.

Electric power, generated on the property by a Diesel engine and steam turbines, is used. Installation of additional Diesel engine units is planned to replace the steam-turbine plant, which is to be retained for emergency use. Total capacity of the power plant will then be more than 1,500 hp. Uninterrupted power supply is of prime importance, inasmuch as many of the operations at the plant are continuous.

Much interest on the part of both the employees and the company is taken in welfare and safety activities. All machinery is guarded to conform with rules and regulations of the National Safety Council. Safety work is supervised by a safety committee, and daily inspection of safety equipment is made by a safety inspector. A high standard is maintained in the living conditions of both white and negro employees. All houses on the property are equipped with electric lights and have running water service.

Acknowledgment is gratefully made to the officials of the Attapulgus Clay Company for permission to publish the foregoing account, and particularly to C. M. Shaeffer, vice-president in charge of operations, who furnished information presented, as well as drawings and photographs.

One of the new 29-ton steam locomotives of special design used in transporting clay from the mine to the wet clay shed

Metallurgical Efficiency of a Classifier

A. C. Halferdahl

CLASSIFIER efficiency is commonly determined by calculation from screen analyses of classifier products, as explained in the textbooks. A recent paper by Luyken and Bierbrauer (Tech. Pub. 214, A.I.M.E.) states that the absolute efficiency of a classifier can be computed from the percentages of oversize in feed, sand, and overflow. More recently, A. W. Fahrenwald has put forward an experimental method which promises much on certain classes of ores, but it is not clear that his method is workable on ores containing a magnetic constituent.

In these days of selective flotation, where fine-grinding mills are operated in circuit with classifiers which are usually of the Dorr type, adequate liberation of the sulphide portion of an ore from the gangue may occur at some specified size which is considerably larger than the size necessary to liberate the associated sulphides. Under such conditions, screen sizing tests and efficiencies calculated therefrom on different ores must be made with caution when screen sizing tests alone are available.

The chief matter of interest is obviously the most profitable degree of liberation of valuable minerals, and the securing of such results may rest in a large degree upon the choice of classifier. To clarify the foregoing statements, certain data are submitted, obtained during the first year of operation (1924) of the Anyox mill of the Granby company. The ore was a low-grade copper ore in which the copper occurred as chalcopyrite associated with pyrite and pyrrhotite in an altered gangue. Gold and silver content was very low. It was early realized that the sulphide minerals were intimately associated and that effective liberation of the chalcopyrite from its associated sulphides was necessary.

The mill as constructed contained two types of classifiers, one a Dorr and the other of the Esperanza type. Both were of practically the same settling area and each was operated in closed circuit with mills handling the same tonnage of ore.

The classifier products and feed were sampled for several days, so the samples were reliable averages. The first procedure was to size each product by screening, with the results given in Table I. Subsequent detailed results are given for the overflow products only, out of respect to the reader, although the classifier feeds and sands were investigated.

From appearances, it might be concluded that the Dorr classifier gave a slightly better liberation of mineral in the overflow. This could be attributable to the small difference in the ore treated. However, the following tests were made on each screen size of the classifier overflows: First a magnetic portion was separated carefully by a small electromagnet from each screen size, including the minus-200-mesh fines. The amount of material lifted by the magnet depends partly upon the strength of the field, and slightly different results would be obtained with a different magnet. Then by use of methylene iodide (specific gravity 3.2), the non-magnetic portion of each mesh was separated into sink and float portions, but this separation was omitted on the minus-200-mesh fines. Every portion separated was weighed and assayed, with the results given in Table II.

The separation into portions is not to be taken as absolutely sharp. That is, some pyrrhotite as very small included particles is present in the non-magnetic portions and, as noted, a considerable amount of gangue accompanies the magnetic portion. The calculations are indicative only of the way in which the constituents are present at various mesh sizes.

A few facts stand out quite sharply: Gangue and sulphides are fairly intimately associated, but the sulphides are more intimate in their association. Very efficient classification must be secured in order to eliminate excessive grinding of gangue, yet liberation of the maximum amount of sulphides attached to the gangue must be obtained to make a satisfactory concentrate and tailing. The gangue is being pulverized selectively in both cases, but more so with the Esperanza type of machine. It will be noted that the copper-pyrrhotite association is broken up only at sizes finer than minus-200 mesh. Fortunately, the magnetic particles are mechanically flocculated, and so are kept in the grinding circuit longer. Tailing losses may be expected to show up in the coarser sizes because of the intimate chalcopyrite attachment and because pyrrhotite is quite easily depressed in the flotation and carries copper with it. One interesting feature is that the gangue not lifted by the magnet is reasonably free of copper at 65 mesh. This again points to the advisability of larger classifier capacity and makes it necessary, in securing higher efficiency, to eliminate gangue as rapidly as possible from the circuit once the gangue is free of copper. It was also interesting to find, both in the preliminary laboratory tests and in the mill, that the pyrrhotite-chalcopyrite magnetic material accumulated in a circulating load of middling. This fact indicated that regrinding of middling would probably be advisable unless adequate liberation could in some way be obtained in the grinding-classifier circuits.

Microscopic examination of each of the products separated as described was made. The chalcopyrite-pyrite association appeared broken at or just below 150 mesh. This was practically confirmed by other work. Also, if the concentrate does not run higher than 10 per cent copper, no pyrite is being discarded in the tailing.

The geologists stated that ore deposition was in two stages, in one of which, pyrite, accompanied by chalcopyrite, was deposited, and in the other, chalcopyrite accompanied by pyrrhotite. This may account for the associations of sulphides and for the procedures necessary to secure good results.

The data appear to show that the Dorr classifier gave a little better liberation of minerals than that of the Esperanza type, but the chief conclusion arrived at was that the classifier capacity was quite inadequate. A larger classifier would permit of a denser overflow and thereby tend perhaps to increase the hindered settling effect which is desir

Table I

Esperanza Classifier Overflow

Mesh	Original Screen Analyses: Per Cent Weight	Original Screen Analyses: Cumulative per Cent Weight	Assays, per Cent: Cu	Fe	S	"Insol."	Per Cent Wt. Cu. This Mesh	Cumulative per Cent Wt. Cu	Per Cent Wt. Fe This Mesh	Cumulative per Cent Wt. Fe	Per Cent Wt. S This Mesh	Cumulative per Cent Wt. S	Per Cent Wt. "Insol." This Mesh	Cumulative per Cent Wt. "Insol."
+ 35	0.93	0.93	0.38	8.4	2.3	71.9	0.88	0.88	2.15	2.15	0.94	0.94	4.62	4.62
+ 48	2.88	3.81												
+ 65	4.60	8.41	0.62	9.3	2.8	69.1	1.73	2.61	2.87	5.02	1.38	2.32	5.36	9.98
+100	10.32	18.73	0.97	10.3	4.4	67.4	6.07	8.68	7.14	12.16	4.85	7.17	11.73	21.71
+150	12.84	31.57	1.62	18.6	10.7	56.8	12.62	21.30	16.04	28.20	14.67	21.84	12.30	34.01
+200	7.46	39.03	2.02	19.1	11.5	55.5	9.14	30.44	9.57	37.77	9.16	31.00	6.98	40.99
—200	60.97	100.00	1.88	15.2	10.6	57.4	69.56	100.00	62.23	100.00	69.00	100.00	59.01	100.00

Original Assays: Cu 1.65; Fe 14.9; S 9.4; "Insol." 59.3

Dorr Classifier Overflow

Mesh	Original Screen Analyses: Per Cent Weight	Original Screen Analyses: Cumulative per Cent Weight	Assays, per Cent: Cu	Fe	S	"Insol."	Per Cent Wt. Cu. This Mesh	Cumulative per Cent Wt. Cu	Per Cent Wt. Fe This Mesh	Cumulative per Cent Wt. Fe	Per Cent Wt. S This Mesh	Cumulative per Cent Wt. S	Per Cent Wt. "Insol." This Mesh	Cumulative per Cent Wt. "Insol."
+ 35	0.78	0.78	0.33	7.7	1.8	71.2	0.66	0.66	1.64	1.64	0.77	0.77	4.40	4.40
+ 48	2.61	3.39												
+ 65	4.79	8.18	0.56	8.9	2.5	68.4	1.57	2.23	2.67	4.31	1.51	2.28	5.97	10.37
+100	10.60	18.78	1.11	13.1	6.6	63.1	6.89	9.12	8.71	13.02	8.83	11.11	12.19	22.56
+150	11.56	30.34	1.61	16.4	9.5	59.2	10.90	20.02	11.89	24.91	12.39	23.50	12.47	35.03
+200	7.39	37.73	2.04	21.2	12.1	50.8	8.83	28.85	9.83	34.74	11.28	34.78	6.84	41.87
—200	62.27	100.00	1.95	16.7	8.3	51.2	71.15	100.00	65.26	100.00	65.23	100.00	58.13	100.00

Original Assays: Cu 1.71; Fe 15.9; S 7.9; "Insol." 54.9.

Esperanza Classifier

Mesh	Sand: Per Cent Weight	Sand: Cumulative per Cent Weight	Feed: Per Cent Weight	Feed: Cumulative per Cent Weight
+ 35	11.23	11.23	6.90	6.90
+ 48	13.23	24.46	7.51	14.41
+ 65	14.84	39.30	10.03	24.44
+100	23.76	63.06	17.48	41.92
+150	19.74	82.80	12.07	53.99
+200	5.05	87.85	7.47	61.46
—200	12.15	100.00	38.54	100.00

Over 50 per cent of the classifier sand was lifted by the electromagnet.

Dorr Classifier

Sand: Per Cent Weight	Sand: Cumulative Weight	Feed: Per Cent Weight	Feed: Cumulative Weight
12.38	12.38	10.68	10.68
12.76	25.14	9.83	20.51
16.68	41.82	12.45	32.96
25.35	67.17	19.80	52.76
14.27	81.44	11.94	64.90
5.72	87.16	6.73	71.43
12.84	100.00	28.57	100.00

Table II

Esperanza Type Classifier Overflow

Mesh	Per Cent Weight on This Mesh: Magnetic Material	Per Cent Weight on This Mesh: Non-Magnetic Material	Cumulative Weight, per Cent Total: Magnetic Material	Cumulative Weight, per Cent Total: Non-Magnetic Material	Per Cent Weight This Mesh of Float in Non-Magnetic	Per Cent Weight This Mesh of Sink in Non-Magnetic	Cumulative Weight per Cent Total Float in Non-Magnetic	Cumulative Weight per Cent Total Sink in Non-Magnetic
+ 35	32.1	67.9	0.30	0.63	98.54	1.46	2.81	0.04
+ 48	22.8	77.2	0.96	2.85				
+ 65	19.9	80.1	1.88	6.53	97.33	2.67	6.39	0.14
+100	17.5	82.5	3.69	15.04	93.11	6.89	14.31	0.73
+150	30.4	69.6	7.59	23.98	83.23	16.77	21.75	2.23
+200	24.7	75.3	9.43	29.60	79.78	20.22	26.23	3.37
—200	13.2	86.8	17.48	82.52	.....	.....	.....	.....

Mesh	Assays on Non-Magnetic: Cu	Fe	S	"Insol."	Assays on Non-Magnetic Float Material: Cu	Fe	S	"Insol."	Assays on Non-Magnetic Sink Material: Cu	Fe	S	"Insol."	Assays on Non-Magnetic Material—Float and Sink Average: Cu	Fe	S	"Insol."
+ 48	0.58	12.4	3.4	63.4	0.21	5.7	0.9	75.4	8.26	26.3	26.7	31.1	0.33	6.0	1.3	74.8
+ 65	0.92	18.2	6.5	57.0	0.25	6.4	1.1	73.6	11.20	31.2	31.0	19.0	0.54	7.1	1.9	72.1
+100	1.15	21.8	8.2	48.8	0.21	5.8	1.0	75.7	10.68	36.7	38.8	11.2	0.93	7.9	3.6	71.3
+150	1.31	36.1	17.0	36.5	0.25	4.9	0.8	78.0	9.28	40.8	43.6	4.8	1.76	10.9	8.0	65.7
+200	1.24	41.6	17.4	28.4	0.20	4.6	1.1	79.0	10.44	39.5	42.4	6.6	2.27	11.7	9.5	64.4
—200	0.59	43.4	19.6	28.8	....	....	....	....	....	....	....	....	2.08	10.9	5.6	57.4

Mesh	Per Cent Cu This Mesh in Magnetic Material	Per Cent Cu This Mesh in Float Material	Per Cent Cu This Mesh in Sink Material	Cumulative per Cent Cu in Magnetic Material	Cumulative per Cent Cu in Float Material	Cumulative per Cent Cu in Sink Material	Cumulative per Cent Cu in Non-Magnetic Material
+ 48	45.4	34.4	20.2	0.40	0.30	0.28	0.58
+ 65	29.7	31.5	38.8	0.91	0.84	0.96	1.80
+100	20.8	16.6	62.6	2.17	1.85	4.76	6.61
+150	24.4	8.9	66.7	5.24	2.97	13.19	16.16
+200	15.2	5.9	78.9	6.63	3.51	20.40	23.91
—200	4.1	95.9		9.48	....	.....	90.52

Rake Type Classifier Overflow

Mesh	Per Cent Weight on This Mesh: Magnetic Material	Per Cent Weight on This Mesh: Non-Magnetic Material	Cumulative Weight, per Cent Total: Magnetic Material	Cumulative Weight, per Cent Total: Non-Magnetic Material	Per Cent Weight This Mesh of Float in Non-Magnetic	Per Cent Weight This Mesh of Sink in Non-Magnetic	Cumulative Weight per Cent Total Float in Non-Magnetic	Cumulative Weight per Cent Total Sink in Non-Magnetic
+ 35	31.7	68.3	0.25	0.53	99.11	0.89	2.51	0.02
+ 48	23.3	76.7	0.86	2.53				
+ 65	18.7	81.3	1.76	6.42	97.28	2.72	6.29	0.13
+100	16.9	83.1	3.55	15.23	88.64	11.36	14.10	1.13
+150	21.9	78.1	6.08	24.26	83.93	16.07	21.68	2.58
+200	24.9	75.1	7.92	26.81	77.92	22.08	26.00	3.81
—200	14.1	85.9	16.70	83.30	.....	.....	.....	.....

Mesh	Assays on Non-Magnetic: Cu	Fe	S	"Insol."	Assays on Non-Magnetic Float Material: Cu	Fe	S	"Insol."	Assays on Non-Magnetic Sink Material: Cu	Fe	S	"Insol."	Assays on Non-Magnetic Material—Float and Sink Average: Cu	Fe	S	"Insol."
+ 48	0.48	11.6	2.9	65.9	0.21	6.2	1.1	73.4	8.52	31.1	30.3	30.0	0.28	6.4	1.4	73.0
+ 65	0.91	17.1	5.5	58.2	0.22	6.3	0.8	73.0	9.67	32.7	36.4	15.6	0.48	7.0	1.8	71.4
+100	1.20	31.0	13.2	40.6	0.18	5.9	0.6	75.0	8.16	37.8	41.0	10.8	1.09	9.5	5.2	67.7
+150	1.27	37.5	16.8	33.8	0.18	5.0	0.7	77.7	9.68	39.0	43.1	6.5	1.71	10.5	7.5	66.3
+200	1.21	47.6	18.7	20.5	0.17	4.9	0.7	77.5	9.92	39.4	42.5	6.0	2.32	12.5	9.9	61.7
—200	0.53	44.1	20.8	28.0	....	....	....	....	....	....	....	....	2.18	12.2	6.2	55.0

Mesh	Per Cent Cu This Mesh in Magnetic Material	Per Cent Cu This Mesh in Float Material	Per Cent Cu This Mesh in Sink Material	Cumulative per Cent Cu in Magnetic Material	Cumulative per Cent Cu in Float Material	Cumulative per Cent Cu in Sink Material	Cumulative per Cent Cu in Non-Magnetic Material
+ 48	36.7	46.4	16.9	0.24	0.31	0.11	0.42
+ 65	30.4	31.3	38.3	0.72	0.80	0.71	1.51
+100	18.3	12.0	69.7	1.98	1.63	5.51	7.14
+150	17.2	7.3	75.5	3.85	2.43	13.74	16.17
+200	14.7	4.9	80.4	5.15	2.86	20.84	23.70
—200	3.8	96.2		7.85	....	.....	92.15

able on this ore. Larger classifiers were installed subsequently and with beneficial results.

Determination of the efficiency of the arrangement is difficult. Reference to screen sizing and efficiencies calculated therefrom gives information, but it is not conclusive. I assumed for mill purposes that minus-150-mesh non-magnetic copper was all liberated and that the percentage of such copper of the total copper in the overflow represented the "efficiency" of the grinding-classifier system. This is not right, however, when one considers that much gangue may be, and here actually was, needlessly and wastefully ground finer than necessary to secure adequate liberation of the chalcopyrite. Perhaps an economic index number would be useful: that is, per cent liberation of economic mineral divided by cost of fine grinding and classification per ton, or divided by cost of copper per pound.

Further discussion of the problem of efficiencies of classifier-grinding arrangements should be helpful.

Shrinkage Stoping in Idaho

R. Duncan Gardner

HARMONY MINE, at Baker, Idaho, produces about 150 tons a day of ore assaying 4 per cent copper and carrying traces of gold and silver. The orebody is reached by several adits, one of which is used as the main haulage tunnel. The ore is then transported to the mill by a cable tramway ½ mile long, and the concentrate then hauled 8 miles by truck to the railroad for shipment to a Utah smelter.

At the Harmony the ore occurs in shear zones in thick beds of highly siliceous shale. The strike of the orebodies is N. 40 deg. W. and the dip, 60 to 65 deg. S.E. Orebodies of major size average 5 ft. thick and 80 ft. long, and are mined by shrinkage stoping. The main haulage tunnel, 800 ft. below the outcrop, is 2,000 ft. long, 6x8 ft. in the clear.

All drifts and crosscuts are driven with medium-weight Leyner-type drifters using 1½-in. hollow round steel with lug shank and standard double taper cross bit. Three changes of steel are used for drilling drift rounds, the gages being 2⅝ in., 2½, and 2⅜ in. Tunnel work and drifting are done by contract. Rounds are usually drilled 5½ ft. deep and contain from 17 to 22 holes. An average of 4 ft. is usually broken—though sometimes the average is 5 ft. Fifty pounds of 40 per cent gelatin dynamite is used for blasting each drift round; higher strength has not proved so satisfactory.

Raises are of two size—5x12 ft. to contain a double chute, and 5x7 ft. for a single chute or manway. Stopes are developed for mining by installing double chutes on 40-ft. centers, and manways at 120-ft. intervals. Drilling in all stopes and raises is done with automatically rotated wet stopers. Formerly, 1¼-in. hollow round steel with a standard lug was used, but this was too heavy, so 1-in. quarter octagon is now used, with better efficiency. Grizzlies are made of 60-lb. rails, set 18 in. apart. For bulldozing, a light jackhammer and ⅞-in. hollow hexagon steel are used.

A 10-ton storage-battery locomotive handles all ore through the main haulage tunnel, 2,000 ft. long, pulling a train of 8 to 10 side-dump cars of 2½ tons' capacity per trip. Hoisting through the winze below the 800 level is done with an electric hoist having a rope pull of 3 tons and a speed of 200 f.p.m. at capacity loading. It is operated by a 440-volt, 50-hp. a.c. motor equipped with a variable switch control starter.

The general wage level underground is $6 per day. Contract rates vary from $5 to $8 per foot for drifts, $2.50 to $5 for raises, and $12 to $15 per foot for winzes, the company furnishing machines, tools, steel, and explosives. Cost per unit of work done is about the same by contract or wage system, but speed is about 25 per cent greater by contract. Contract prices in stopes are based upon tons of ore broken, resulting in contractor breaking into walls to get more tonnage, diluting the ore, and thus offsetting saving in cost. A scale is being worked out based upon the maximum width to be broken, the contractor being paid for the advance along the vein at this width, with a higher price allowed if the vein widens appreciably.

Underground costs, in cents per ton, follow:

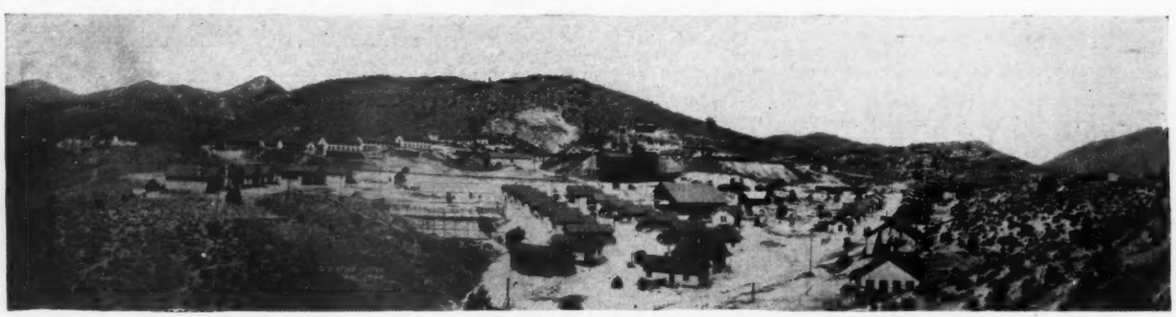
Costs at Harmony Mine

	Labor	Supervision	Air Drills and Steel	Power	Timber	Explosives	Other Supplies	Total
Development..	32	9	3	2	5	9	5	65
Mining.....	65	30	27	16	18	27	22	205
Transportation.	15	..	..	3	..	..	3	21
General.....	16	..	..	1	..	..	6	23
Total.....	128	39	30	22	23	36	36	314

Tons mined: 19,000 in five months, unit costs being summarized as follows:

Labor	Man-Hours per Ton
Breaking (drilling and blasting)..	1.19
Mucking.....	0.06
Haulage.....	0.04
Supervising.....	0.26
General.....	0.15
Total labor underground.....	1.70
Average tons per man-shift.....	4.72
Labor, percentage of total cost...	53.20
Power and Supplies	
Explosives (lb. per ton).....	2.05
Total power (kw.-hr. per ton)...	10.10
Other supplies as per cent of total supplies and power.....	24.50
Supplies and power, per cent of total cost.....	46.80

Brief abstract of U. S. Bureau of Mines Information Circular No. 6240, describing mining practice at the Harmony Mine, Baker, Idaho.



Improved Laboratory Elutriator

And Its Application To Ores

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AT INTERVALS throughout the last three or four years the Mississippi Valley Experiment Station of the U. S. Bureau of Mines, in co-operation with the Missouri School of Mines and Metallurgy, at Rolla, Mo., has given some attention to the elutriation of flotation products that were too fine for separation by means of the customary screens. Observations by the Southeast Missouri lead operators that the part of the flotation tailing passing a 325-mesh screen had the highest lead tenor added incentive to this investigation of sizes finer than 325 and 400 mesh.

Although the first test was made in a crude fashion, it justified the effort. The entire tailing was used; that is, the screenable sizes were retained in the charge. No deflocculator was employed to disperse the slime. Twelve overflow fractions and a residue were made. The first two fractions (Nos. 1 and 2 in Table I) contained the finest part of

Table I—Elutriation of a Flotation Tailing From a Lead Ore

Fraction	Weight, per Cent	Assay, per Cent Lead
Heavy Residue	30.4	0.02
12	4.6	0.06
11	3.8	0.06
10	3.3	0.08
9	2.6	0.12
8	3.9	0.30
7	6.4	0.30
6	6.5	0.40
5	9.2	0.44
4	10.0	0.54
3	10.0	0.52
2	7.7	1.10
1	1.6	0.70
	100.0	

the tailing and had the highest lead content, whereas the coarser material was lean. Chemical determinations revealed that about one-half of the lead in each fraction was oxidized, but this did not becloud the fact that the richest part of the tailing was of a size far below the finest sieve. The rate of the rising currents was not measured, but screen tests of the fractions indicated the grain size. For instance, fraction No. 8 had only 5 per cent of its weight on 325 mesh; hence the first fractions, Nos. 1 and 2, must have been of very fine size.

This work was done in October, 1927. The date is recorded as evidence that elutriation is not a fancy of the moment.

The next test was carried out with a little more precision but without a good elutriator. Samples of both a feed and a tailing were sized hydraulically. The feed was taken off in six fractions, and,

Table II—Elutriation of Flotation Feed and Tailing

Fraction	Weight, per Cent	Assay, per Cent Lead: Feed	Assay, per Cent Lead: Tailing	Approximate Extraction, per Cent
Heavy residue (6)	24.4	1.99	0.09	95
5	11.5	1.28	0.04	97
4	14.0	1.02	0.03	97
3	3.1	1.29	0.09	93
2	6.9	1.52	0.07	95
1	40.1	2.14	0.16	93
Total.....	100.0	1.78	0.10	94

to obtain the same weight-analysis of the tailing, several dozen fractions of it were made. After being weighed, these were grouped to yield the same weight-analysis as the feed. The results are shown in Table II.

As was expected the first tailing overflow, fraction No. 1, had the highest lead content; likewise, the corresponding part of the feed was the highest. Here is a reminder that although inefficiency will probably be proved ultimately, one must not jump to the conclusion that flotation of the finest size is inefficient. Inasmuch as both the feed and the tailing were richest in the finest size, the extraction percentage shown in the last column is about the same as for the others. Parenthetically, it must be said that no rigid method for determining extraction by increments was available; it had to be obtained by difference of assays of feed and tailing.

In the next test the attention was turned from galena to blende. Although it lacked some of the most recent refine-

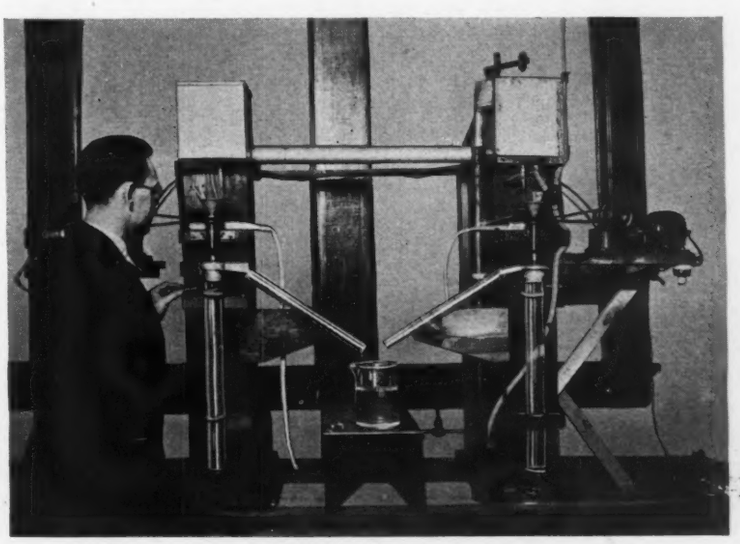

Fig. 1—General arrangement of two elutriators in the laboratory

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ments, the elutriator to be shown later was used. The material was screened at 400 mesh and only the minus-400-mesh portion was elutriated. Gum arabic was used to secure complete dispersion of the fine particles. The results of the test appear in Table III.[1]

Attention is directed to the minus-5-micron size, where the extraction dropped to 62 per cent. This size is about seven times finer than 400 mesh. Although these notes indicate that flotation is poorest in the finest size, they are not intended to offer proof. They are recorded only to arouse interest in the use of the elutriator to size products finer than the finest screen. The application cited is to flotation products, but the field of usefulness is more extensive, as, for instance, in the examination of clays for the ceramic industry.

The elutriator now used is similar to that developed by Gross and his associates at the Intermountain Station of the U. S. Bureau of Mines, Salt Lake City, Utah. They have described it fully and discussed the fundamental principles of elutriation in a recent report.[2] The elutriator described here differs from the one developed by them in the manner of controlling the flow of hydraulic water. They used a $\frac{3}{8}$-in. glass tube for a rotor, and state: "The feed water coming from the constant-level tank is controlled by a circular opening valve, enters the top of the rotor tube. . . ."

The $\frac{3}{8}$-in. glass-tube rotor proved too small, because the stream falling into it entrained air that formed an air lock and thus prevented the descent of the water to the bottom of the rotor. A rotor of $\frac{1}{2}$-in. inside diameter relieved the trouble. Also, the speed of the rotor was reduced to 20 r.p.m. The "circular opening valve" for controlling the flow of the water was unsatisfactory. At the beginning of an elutriation test, while the first overflow is taken, the speed of the flow has to be reduced to

Fig. 2—Spigot and cutter for regulating flow of water to elutriator

"drops." Obviously, no valve is available that will allow water to pass it, hour by hour, in drops; adsorption or minute specks of dirt would choke any small orifice. Because of this choking, capillary tubes also were unsatisfactory. The difficulty experienced in controlling and duplicating the rate of flow of water when using valves or capillary tubes led to the development of a series of cutters after the manner of an ore sampler.

Two elutriators, with their tanks connected and maintained at a constant water level, are shown in Fig. 1. A close-up view of the spigot and one of the cutters is exhibited in Fig. 2. The spigot delivers a calibrated amount of water (master stream) from the constant-level water reservoir. The adaptor (funnel) and a cutter are shown in place. When rotating, the cutter takes all of the master stream part of the time. The remainder of the stream goes to waste.

The series of cutters required is shown in Fig. 3. Progressing from left to right, in the figure the angle of opening or width of cutter is twice that of the previous cutter. The sequence of the series, expressed in degrees, is as follows: 180, 90, 45, 22.5, and 11.25. Only a moment is required to replace one cutter with another. When the whole stream is taken, the cutter represents an opening of 360 deg. When the size of the master stream remains constant, the theoretical flow of water to the elutriator, and consequently the velocity of rising water in the tube, doubles as each cutter is substituted in the series. Table IV indicates the flow of water for each cutter when a standard spigot is used. Inasmuch as the velocity doubles with the use of each cutter, a definite ratio exists between the sizes of particles in each increment produced.

According to Stokes's law, the diameter of particles suspended in a rising current of water varies directly as the square root of the velocity. When the velocity is doubled in successive steps in a series, the ratio of the sizes of particles suspended varies as the square root of the velocity, or as 1.414. This is the ratio of openings in the screen scale as recommended by Rittinger, and is the screen scale commonly employed. The advantage of this continuation of the standard square-root-of-2 screen scale will be appreciated readily.

The master stream must be calibrated

Table III—Screen Sizing and Elutriation of Feed and Tailing from a Mill Treating Zinc Ore

Size	Weight, per Cent Feed	Weight, per Cent Tailing	Assay, per Cent Zinc Feed	Assay, per Cent Zinc Tailing	Approximate Extraction, per Cent
Plus 48 mesh	1.2	1.5	1.58	0.53	66
— 48 + 65 mesh	6.6	10.3	1.41	0.39	72
— 65 + 100 mesh	19.1	22.5	2.01	0.39	81
—100 + 150 mesh	14.0	11.6	2.57	0.52	80
—150 + 200 mesh	8.4	8.1	7.00	0.63	91
—200 + 270 mesh	10.2	8.9	10.34	0.54	95
—270 + 400 mesh (38 microns)	9.3	7.4	11.24	0.49	96
38 to 25 microns	2.0	9.2	16.08	0.75	95
25 to 15 microns	9.5	3.6	9.60	0.71	93
15 to 10 microns	10.0	7.5	6.68	0.96	86
10 to 5 microns	3.6	.....	6.92	.....	..
—5 microns	6.1	9.4	6.36	2.43	62
Totals	100.0	100.0	6.14	0.75	88

Table IV—Flow of Water With a Series of Cutters

Cutter No.	Angle of Opening, Deg.	Cubic Centimeters per Second	Rising Velocity in Elutriator, Millimeters per Second
1	11.25	3.1	0.030
2	22.5	6.2	0.060
3	45.0	12.4	0.121
4	90.0	24.0	0.234
5	180.0	48.4	0.472
6	360.0	96.0	0.936

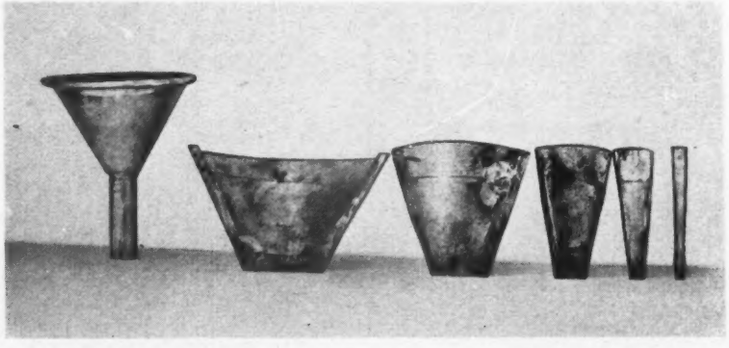

Fig. 3—Series of cutters. Angles of opening are: 180, 90, 45, 22.5, and 11.25 deg. Cutter holder is on the left

[1]This study was pursued by Gunther Frötscher, research fellow, in the school year 1928-1929. Acknowledgment is here made of the liberal use of his notes.

[2]Gross, John, Zimmerley, S. R., and Probert, Alan: "A Method for the Sizing of Ore by Elutriation." U. S. Bureau of Mines Report of Investigation No. 2,951.

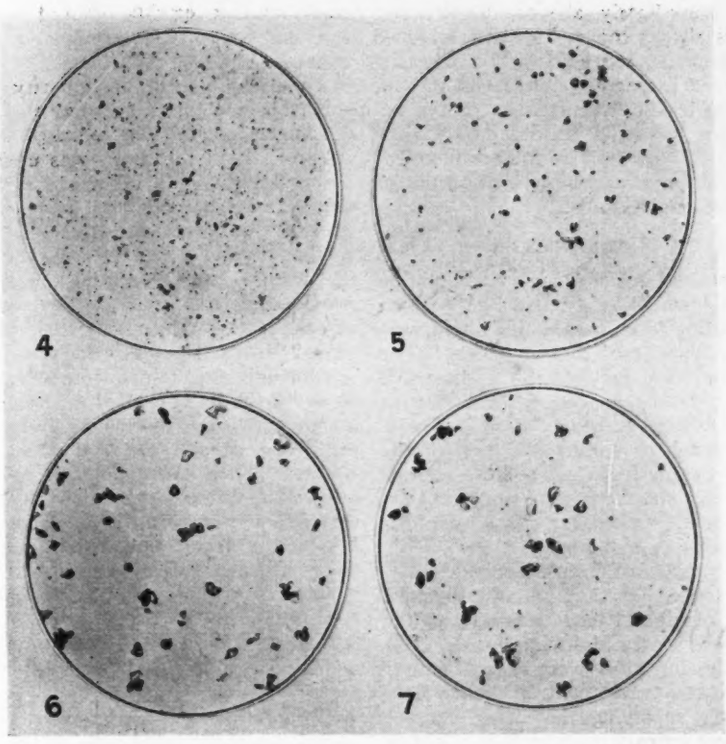

Fig. 4—First overflow; size of average large grain: minus 0.005 mm.
Fig. 5—Second overflow; size of average large grain: minus 0.007 mm.
Fig. 6—Third overflow; size of average large grain: minus 0.009 mm.
Fig. 7—Fourth overflow; size of average large grain: minus 0.013 mm.

Table V—Complete Sizing Analysis of Ottawa Sand on an Extended Screen Scale, With the Ratio of Openings of 1.414

Product	Grain Size, Millimeters	Weight per Cent	Cumulative Weight, per Cent
—100 mesh	—0.147	.....	.....
—100 + 150 mesh	—0.147 + 0.104	3.5	3.5
—150 + 200 mesh	—0.104 + 0.074	7.6	11.1
—200 + 270 mesh	—0.074 + 0.053	9.1	20.2
—270 + 400 mesh	—0.053 + 0.038	16.4	36.6
Residue	—0.038 + 0.027	18.3	54.9
Sixth overflow	—0.027 + 0.019	15.7	70.6
Fifth overflow	—0.019 + 0.013	15.1	85.7
Fourth overflow	—0.013 + 0.009	5.7	91.4
Third overflow	—0.009 + 0.007	2.1	93.5
Second overflow	—0.007 + 0.005	2.0	95.5
First overflow	—0.005 + 0.000	4.5	100.0
Composite.....		100.0	

large grains are in many cases aggregates of smaller grains not differentiated at the magnification employed. A means of complete dispersion for photographic purposes has not been developed.

Grain size as actually determined corresponds closely, according to Stokes's law, to the theoretical size.

The use of cutters to regulate the flow of water makes possible accurate sizing of material finer than 400 mesh and thus extends the scale. If the elutriator were big enough to admit a large initial stream, valve control could be used, but the necessity of adjustment for each cut would be disadvantageous.

Removal of the water from the first overflow fractions has been difficult, closely; otherwise a continuation of the Rittinger screen scale does not result. (Parenthetically, the fact should be recorded that the spigot employed is large enough to avoid choking.) The theoretical flow of water necessary to keep in suspension grains of the next screen size below 400 mesh in the prolonged scale has been found to be a good starting point. Actual values must be determined by experiment.

To standardize the elutriator, a sample of pulverized Ottawa sand, which was screen-sized down to 400 mesh, was used; the minus-400-mesh material served as feed. Six overflow products and a residue were made. Table V gives the complete per-cent-weight analysis and the grain size expected. The average-large-grain size was determined by actual miscroscopic measurement. Calibration of the sizes checked fairly well with the expected sizes.

For record, the products were photographed at a magnification of 100 diameters. These are shown in Figs. 4 to 9, inclusive. The residue appears in Fig. 10. Fig. 11 is a photograph of a stage micrometer at the same magnification. The distance between the fine lines represents 10 microns, or 0.01 mm., whereas the other lines are spaced 100 microns, or 0.10 mm., apart. The scale is given to help visualize the size of the grains.

A comparison of the foregoing illustrations shows a marked grading up in size from the "first overflow" to the "residue." The large variation in grain size in the first overflow (Fig. 4) is to be expected; the ratio of grain size from 0 to about 5 microns is infinity, and the particles appearing as

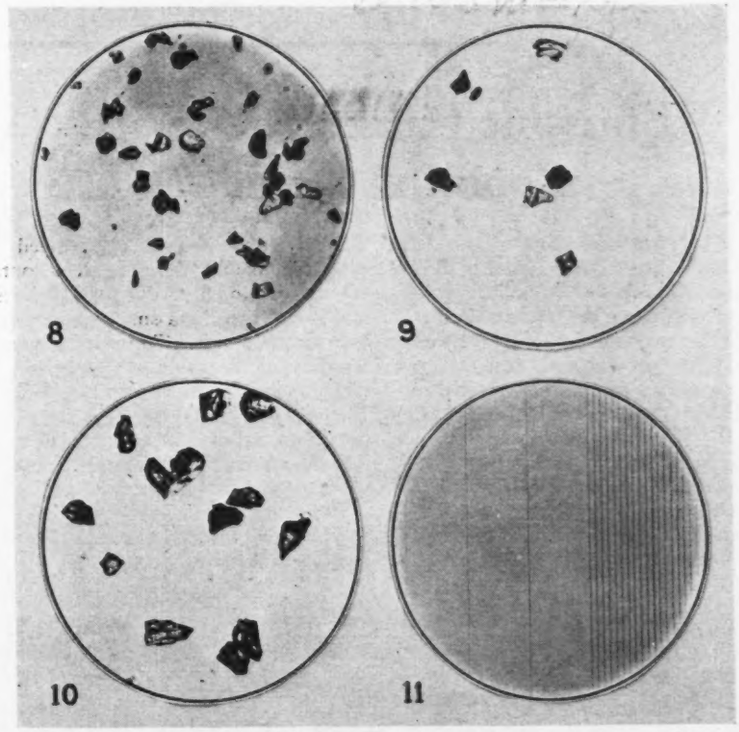

Fig. 8—Fifth overflow; size of average large grain: minus 0.019 mm.
Fig. 9—Sixth overflow; size of average large grain: minus 0.027 mm.
Fig. 10—Residue; grain size ranges from minus 0.038 mm. to plus 0.027 mm. Fig. 11—Stage micrometer; the finer scale is 10 microns or about one-fourth the size of the openings in a 400-mesh sieve

If thorough deflocculation is maintained in the elutriator, the effluent also will be dispersed and difficult to settle. Gum arabic seems to be the best deflocculator, but no satisfactory means of neutralizing it in the effluent has been found. Boiling to dryness would not be satisfactory, because the gum arabic would contaminate the ore. After much experimenting a centrifugal machine was adopted as the best means of settling the solids. The centrifuge used has a capacity of 200c.c. As soon as this amount has overflowed it is placed in the centrifuge to be settled while the next charge is in preparation. Fortunately, centrifuging is necessary only for the minus-10-micron size. The coarser material—that is, all but the first two overflows—will settle on standing.

This dissertation would be incomplete without giving cognizance to the fact that, strictly considered, hydraulic sizing can be performed only on a one-mineral product. In the early part of the work, it was thought that the respective densities of mineral grains finer than 400 mesh would not affect the settling rate; but positive proof to the contrary has been obtained. Only one example will be cited, as shown in Table III. There the first size finer than 400 mesh has a higher zinc content than the one immediately below and that immediately above; the coarsest size is always enriched when a screened product is sent to a commercial classifier preparing table feeds. Proof that hydraulic classification of the respective minerals extends into sizes finer than 400 mesh is further justification for the precise classification of the finest table feeds.

Conclusions

Operators in some of the lead flotation plants have observed that the part of the tailing that passed 325 mesh was richer than the coarser sizes. The segregation of the lead in the slime was also shown by analyzing the undersize of a 400-mesh screen.

Inasmuch as closer allocation of the losses was desired, and because screens finer than 400 mesh were not available, elutriation, or sizing by hydraulic classification, was used.

The first elutriation tests were somewhat crude, but they showed that the tailing of highest tenor was of sizes far below the aforesaid 400-mesh size. The old-style elutriators were unsatisfactory, because the valves controlling the flow of water supplying the rising current could not be calibrated to give a steady and unvariable flow of water. To segregate the finest slime, the water had to be admitted to the elutriator in "drops," and this required an orifice so small that it quickly choked by adsorption or because of other interferences.

To overcome the irregularity of a small opening, a cutter, after the manner of an ore sampler, taking "all the stream part of the time" was used. It diverted a portion of a "master stream" that was large enough to flow without choking. A series of cutters was made so that each would double the flow of the former, and give grain sizes approximating the usual square-root-of-2 screen scale. Thus only the master stream had to be calibrated.

Although the cutters were developed to avoid the use of small orifices, they are of advantage also where elutriators are large enough to require a large stream. Their advantage in general use lies in the fact that, after the master stream is calibrated, no valves are present to require further attention; the replacement of one cutter with another will accomplish what could be done otherwise only by a series of trial settings of a valve.

The elutriation tests showed that, whereas it was known in the beginning that the minus-400-mesh size was of highest tenor, the losses were segregated in the 5-micron size. Elutriation of flotation feeds and tailing will have to be continued before general statements about losses are made.

Efficient Cable Reel With Spooling Device

AT THE surface plant of the Park Utah Consolidated Mining Company's unit at Keetley, Utah, all gathering and switching operations are performed by two small General Electric trolley-type locomotives, each of two tons' capacity, set in tandem and operated with one controller and trolley pole. To permit its operation alongside the railroad company's loading tracks, where an overhead trolley wire could not be installed, a small four-wheel tender, equipped with a standard horizontal General Electric cable reel, as shown in Fig. 1, was recently developed and placed in operation. The reel contains 600 ft. of No. 6 AWG insulated cable, and is operated by a small standard 250-volt torque motor. To insure a compact winding of the cable, a simple and efficient spooling device, as illustrated in Fig. 2, was installed, consisting of a horizontal crankshaft and a small reduction-gear unit, direct-connected with the vertical electrically operated reel shaft; a connecting rod; and a mild-steel lever, equipped with a cable guide. The horizontal crankshaft is so geared that the up or down movement of the lever holding the cable guide for each turn of the reel corresponds to the thickness of the cable. Without a spooling device, only about 400 ft. of cable can be wound on the aforementioned type of reel, and with the new device a total of 750 ft. can be wound without difficulty. The cable reel is protected by a sheet-iron hood covering the tender.

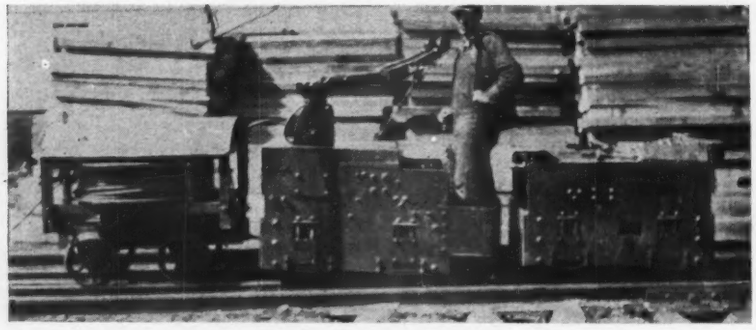

Fig. 1—Trolley-type locomotive and tender

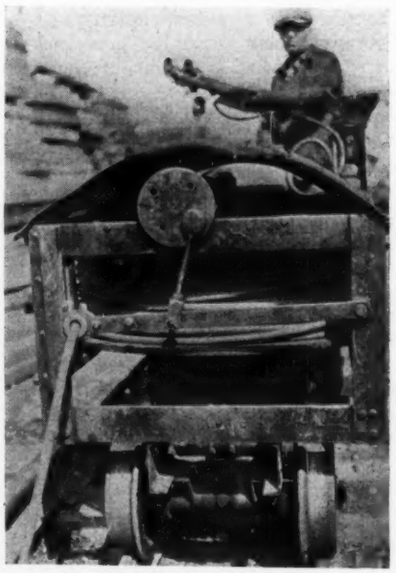

Fig. 2—Cable-winding device

Ore Hoisting in the Butte District

Part II

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Mining Engineer, Butte, Montana

Structural Engineer, Anaconda Copper Mining Company

A COMPLETE automatic skip-hoisting surface plant may be designed and installed in the early stages of the development of a mine. This, however, is not general practice. Usually, a steel headframe and automatic skip-hoisting apparatus replaces a timber structure, which type of headframe is used almost universally in the infancy of a mine, when the car-to-cage system of ore hoisting is generally employed.

The daily tonnage that may be assumed in planning a new installation is controlled by several factors. In the first case, the cross-section assumed for the shaft will limit the cross-section of the skip, and, in turn, the capacities of the cages, skips, and dumping apparatus will limit the daily tonnage. Costly experience has proved that shafts of certain cross-sections are most economical for deep vertical hoisting. One large corporation has adopted a cross-section of 4 ft. 6 in. x 5 ft. for hoisting from a depth of 5,100 ft. The principal dimensions and arrangement of several typical shaft cross-sections employed at some of the large mines in the Butte district are shown in Fig. 1. The cross-section of the shaft having been determined, the capacities of cars and skips are regulated by their respective depths, which dimension is generally the controlling factor in their design.

Typical examples of standard cages used by nearly all the large operating companies at Butte are shown in Figs. 2 and 3. Fig. 2 illustrates the present trend in the design of skip-deck cages, whereas Fig. 3 shows the type of upper-man-deck cage used for both main and chippy hoisting compartments. The standard lower-man-deck cage, also used in both main and chippy compartments, is shown in Fig. 4.

The skip-deck cage (Fig. 2), beneath which a skip is permanently suspended by means of a short drawbar, is heavier in design than either the upper-man-deck cage (Fig. 3) or the lower-man-deck cage (Fig. 4). The latter two are primarily designed for man-trip hoisting and for interlevel transportation of mine supplies. In moving men in and out of the mines at the beginning and end of shifts, multiple deck trips are used, which generally consist of one bonneted top deck and three lower decks for the main hoisting compartments, and of one top deck and two lower decks for the chippy compartment.

Generally, the skip-deck cage (Fig. 2) consists of a grilled platform, with car tracks for the caging of cars. This platform is bolted and riveted to the lower ends of two central suspension bars, known as wing-bars, which are fastened by angles to the bottom of the platform and the lower skip crosshead. To the wing bars are also riveted the long guide shoes or runners. Two sway braces, which steady and reinforce the

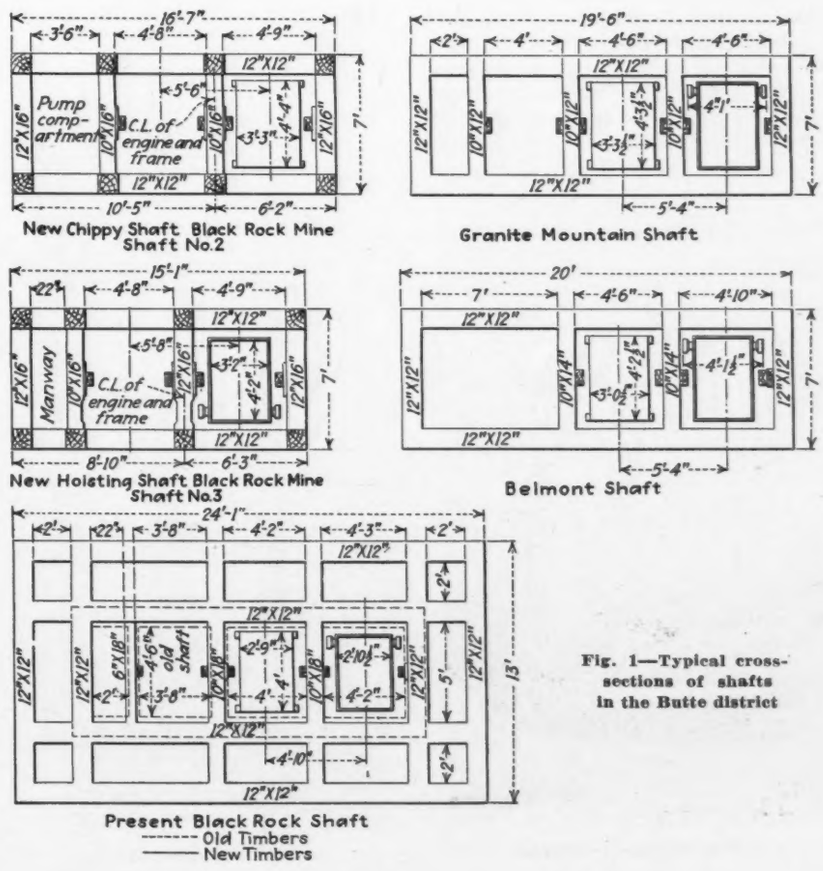


Fig. 1—Typical cross-sections of shafts in the Butte district

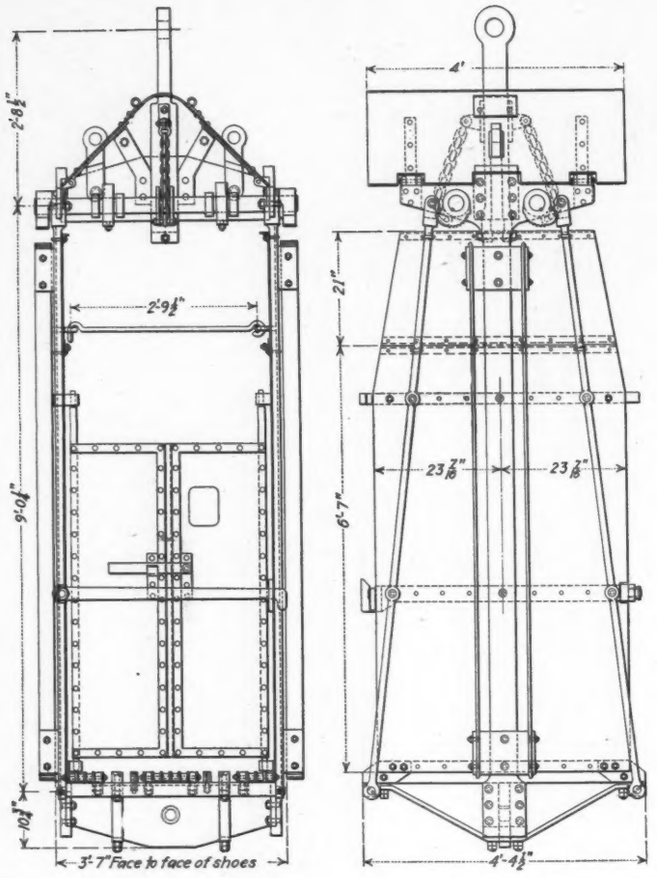


Fig. 2—General design of skip-deck cage

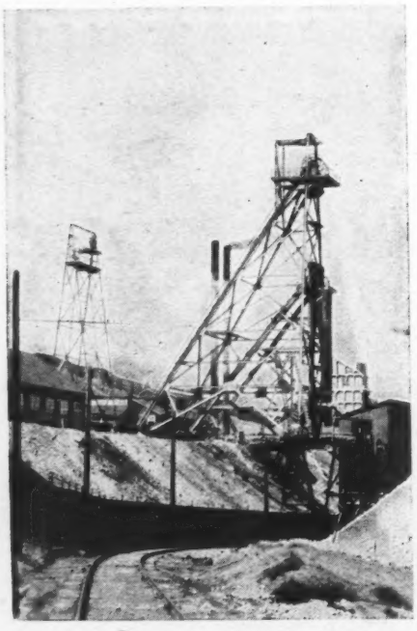
Fig. 3 (below)—General design of upper-man-deck cage

splinter. Cage doors consist of steel sheets, as high as a man's shoulders, with a handhole to facilitate opening and closing from the inside, and are held shut by the tongue latch and a heavy drop bar that rests in the center bar notch. The hand rail is used by the men to steady themselves when the cage is only partly loaded.

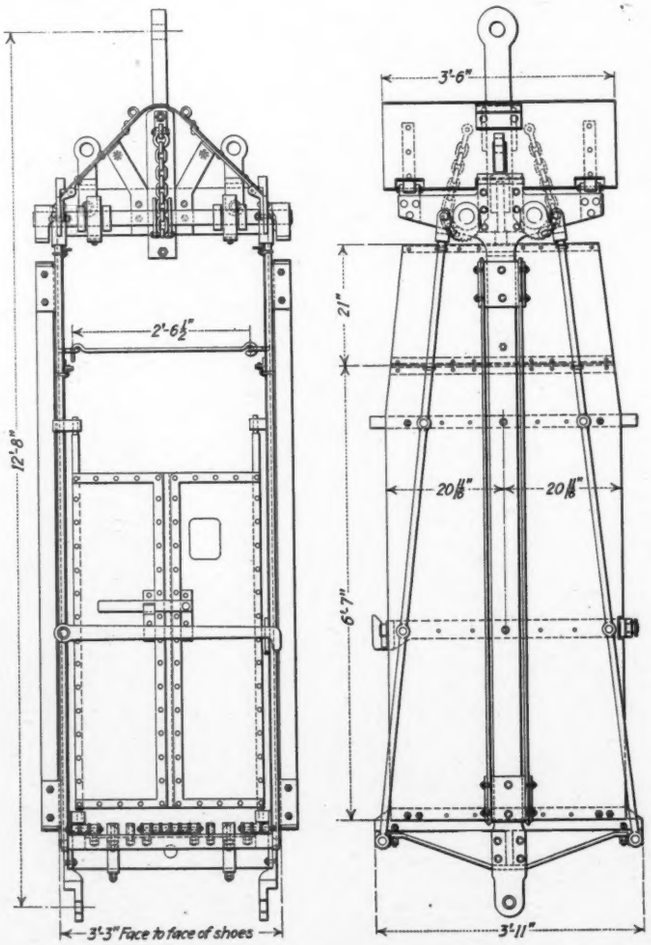
The safety catch comprises two jackshafts on which are keyed toothed safety dogs or involute cams. All parts are of cast steel. The jackshafts, with the keyed dogs, are coupled to the cable drawbar through sheaves and $\frac{9}{16}$-in. standard short-link chains, 19 in. long. Should the cable slacken or break, the dogs are rotated against the guides by springs. To protect the men from falling objects, the top decks are equipped with heavy steel bonnets, hinged at the sides and supported by the upper crosshead. To this upper crosshead are attached eyebars, which receive the hooks from the change rig chain blocks. The skip-deck cage is of substantial construction, designed not only for long-wearing qualities, but also to resist corrosion from acid water.

The upper-man-deck cage (Fig. 3) is similar in construction to the skip-deck cage, with the exception of the lower crosshead, which, in the upper-man-deck cage, is designed for multiple deck hoisting, having "eyes" that re-

platform, extend from the platform to the wing bars. To reinforce the skip crosshead, the straps or deck braces are bolted in place. The entire cage proper is sheathed with $\frac{1}{4}$-in. steel plate; the sides in contact with the guides are sheathed somewhat higher than the long guideshoes to prevent injury of men in the close-packed decks should the guides



New Badger State headframe



New Belmont headframe

tain the suspension members of the lower decks, shown in Fig. 4. It is also equipped with long guideshoes that prevent excessive stresses in the guides, with resulting loosening of the lag-screws. All guideshoes are renewable.

Deviation from aforementioned types of cages is shown in Fig. 5. This cage is unusual in that it is suspended directly beneath the accompanying skip, is not bonneted, does not carry "safety dogs," and doors and gates are made up of a lattice of metal bars rather than sheet steel. With this type of cage, no change-over device is needed. The accompanying skip is bonneted, equipped with "safety dogs," and is fitted with a removable false bottom, permitting the skip to be used to transport men. This type of cage is employed at the Pittsmont mine.

Only one type of automatic skip-dumping rig has been generally adopted in the Butte district for large-scale production. The essential elements of the rig comprise: (1) A cage, which has already been discussed; (2) an automatic dumping skip under the control of the hoisting engineer and station tenders; (3) a skip-dumping mechanism which tips and empties the skips automatically and returns them in their proper position in the shaft compartment; (4) skip bins which act as storage hoppers between the skips and the motor lorry that transports the ore from the skip bins to the terminal bunkers; (5) a regular transfer service between the skip bins and the terminal bunkers.

Nearly all of the large producers in the district use the automatic skip suspended beneath a skip-deck cage. The most widely adopted skips of the cage-skip type are shown in Figs. 6 and 7. These are the largest skips used in the district, both having a capacity of 10 tons, or 145 cu.ft. The skip shown in Fig. 6, which is the deepest in the district, is employed in the new 5,100-ft. installation at the Mountain Consolidated, Belmont, and Badger State properties. Fig. 7 shows the type of skip employed at the Black Rock mine; this skip has a larger cross-section than any other skip in use in the district. Skip capacities vary, 4-, 5-, 7-, and 10-ton skips being used. All are variations of the Kimberley type of skip. The only property using the Kimberley design at present, however, is the Original mine.

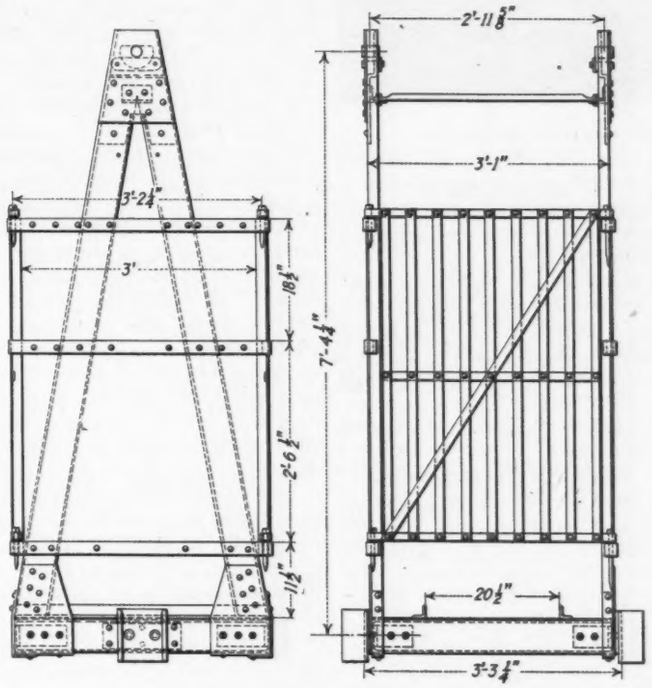


Fig. 5 (above)—Unusual type of cage used at the Pittsmont mine

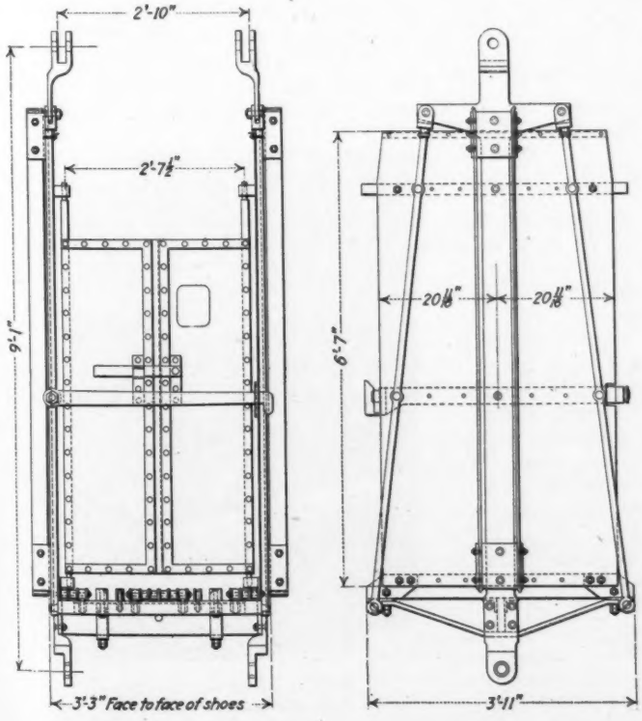


Fig. 4—Standard lower-man-deck cage used in both main and chippy compartments

Excessive vibration and wear on the limiting links and the entire structure led to the development of the modern skips illustrated in Figs. 6 and 7, which, for want of a better name, I shall call the Montana type. The skip body, as shown in Fig. 6, rests on two parallel shafts, A and A_1, bolted to the skip bail. These are far enough apart to insure stability while the skip is being hoisted. One shaft, A_1, passes through two heavy pillow blocks with caps, bolted to the body of the skip, which arrangement permits the skip to rotate about the shaft. The other shaft supports are open pillow blocks, also bolted to the

St. Lawrence headframe

skipbody. In this type of skip the dumping arrangement must be such that the skip body will not reverse and go down the shaft bottom up.

A pair of rollers or "tumbling bars" are attached to the sides of the skip dump in such a position that the horns on the skip, B and B_1, projecting forward from the top of the skip body, will just slide over them. These tumbling bars carry the full weight of the loaded skip, while the guide rollers on the skip, C and C_1, following the dumping arc, are being lifted to the reversed portion of the skip-dump track. Upon reversal, the rollers insure that the skip body will be returned to its normal position. To prevent overturning in the shaft, skips are equipped with safety "half-shoes," D and D_1. This necessitated the introduction of a split-guide arrangement to allow the half-shoes, which are attached to the sides of the skip, to follow the path of the dumping arc.

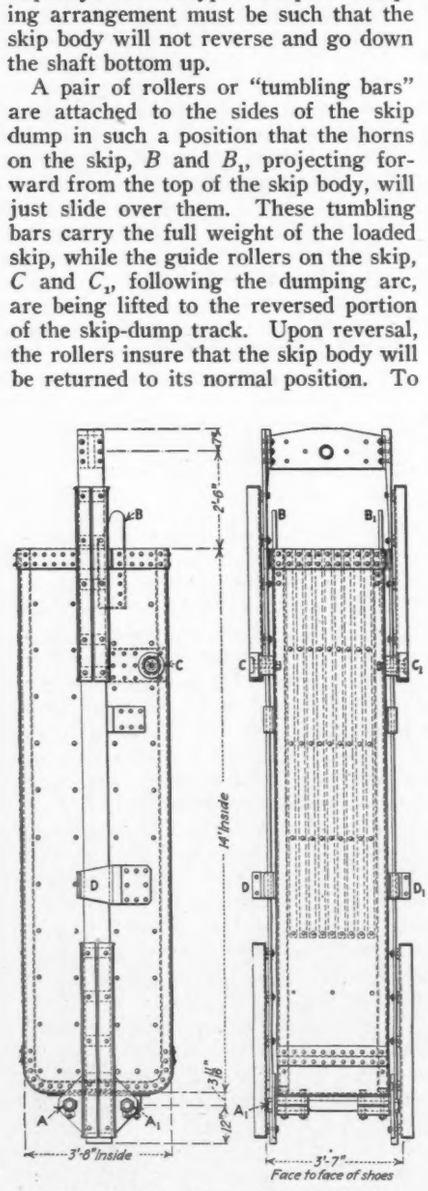


Fig. 6—Skip designed for 5,100-ft. installation

Nearly all the skips used in the district are lined with renewable steel liner-bars, 1x2 in. in cross-section. Skip bottoms are covered with ¼-in. liner plates or sheets. Rubber-strip linings have been tried in skips, but have not been generally adopted.

Skip dumping apparatus and the skip bin are so interrelated as to make the design of each partly dependent on that of the other. The essentials involved in the arrangement are: (1) A dumping arc or track which guides the skip away from the shaft guides and over the skip bins; (2) a split guide to allow the clearing of the half-shoe; (3) tumbling bars, or some other device, to engage the horns on the skip and guide it to the upper reversed track to the full dump position; (4) skip bins which receive the discharged contents of the loaded skip; (5) air-operated gates which control the discharge into the transfer lorry.

The commonest type of dumping apparatus in the Butte district is shown in Fig. 8. In this dumping mechanism, the reversing horns of the skip, B and B_1 (Fig. 6), engage the tumbler bars, E and E_1 (Fig. 8), and the guide rollers of the skip follow the arced track F and F_1 (Fig. 8). In general, the operation is as follows: The ascending skip comes up until the guide rollers of the skip engage the lower limit of the dump track, G and G_1. From this point, the skip body moves away from the prolongation of the vertical guides, following the arc of the track until the horns ride the tumblers, E and E_1. The skip is then lifted vertically until the dump rollers engage the upper portion of the track, H and H_1, travel along which moves the skip to full dump position. In order that the skip body may follow the dump track, to its position over the skip bins, the guides must be split or slotted diagonally, so that the half-shoes will pass across them with ample clearance, while the bail continues to follow the vertical guides, as at I and I_1. In returning the empty skip, the above operations are reversed and automatic, so that, when the skip body comes to the vertical position, the half-shoe recrosses the shaft guide and, upon further descent, engages it and prevents the skip from overturning in the shaft. The position of the shoe on the skip is directly dependent, therefore, upon the depth of the skip and the radius of the dumping arc. Investigation will show that the minimum stresses on the shaft guides will occur when the half-shoes are at the top of the skip body. However, the shoes must be placed low enough to clear the tumblers and especially the dumping track. The position

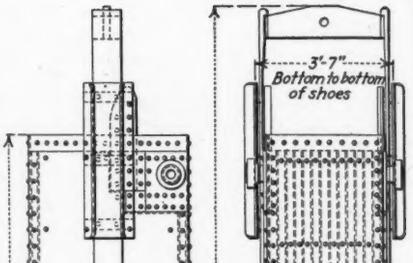
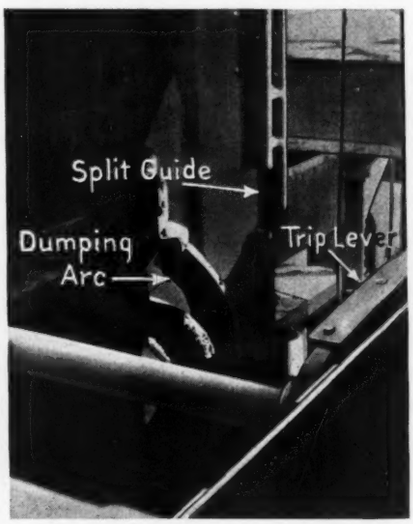


Fig. 7—Skip used at the Black Rock mine

of the half-shoe on the skip and the radius of the dumping arc are found graphically as follows:

The cross-section of the skip body having been determined, a depth of skip is assumed, and a small model skip made to some convenient scale. This is generally made of bristol board or tracing cloth. Holes are cut in the model to represent the true positions of the guide rollers and the body pivot. An interior section is also cut out and backed with tracing cloth. A sketch of the completed dummy is shown in Fig. 9. A prolongation of the vertical shaft guides and the center line of the guide rollers are plotted. An arc is then struck with a trial radius, fixing outward from the center line of the guide rollers, the top of the "tumbler."



Skip dumping arrangement at Pittsmont shaft

By manipulating the dummy skip so that the body pivot or bail will always follow the vertical guide center line, inspection and trial will develop a radius of dumping arc such that the skip will move outward until the horns engage the tumblers. By continually moving the skip upward, it will describe the reversed arc, while the body pivots about the tumblers. Once the dumping arc is found, the position of the split guide is determined. A position of the half-shoe is drawn roughly to scale on the tracing-cloth center of the skip, which is then manipulated through its limited path. A position of the half-shoe, such that it will clear the skip dump and track, is accurately determined by a series of trials. When this position is permanently plotted on the tracing cloth, the guide is slotted diagonally so that the shoe will cross it unhindered. Various positions of the guide rollers and half-shoes can then be readily plotted through their respective slots for any position of the skip.

Skip bins at Butte are of the diaphragm type, in which each hoisting compartment is equipped with an individual skip bin. Many of the separating diaphragms are permanent. In the more recent installations, each skip bin is separated from the other by a steel diaphragm. The skip bins are of rectangular steel construction and are equipped with hopper bottoms, discharging through air-operated gates into lorry cars. These bins are immediately under and support the skip dump proper, the skips discharging directly into them. The sides and bottom of each bin are lined with heavy rails made up in sections of five or six rails each which are bolted into place. In several recent installations, the skip bins have been built in two compartments, and the skip dump provided with air-operated gates so that either skip may be discharged into either compartment. These communicating gates are operated by air cylinders, as are also the various loading gates.

The most recent developments in lorry-car design are shown in Fig. 10. At some of the mines the older types of lorries, consisting of a lorry car and a separate trolley locomotive, are still in use. These are being superseded rapidly by the type shown in Fig. 10, in which the lorry car and the motor unit are integral. This type has been installed at the completely renovated surface plants of the Mountain Consolidated, Belmont, and Badger State properties.

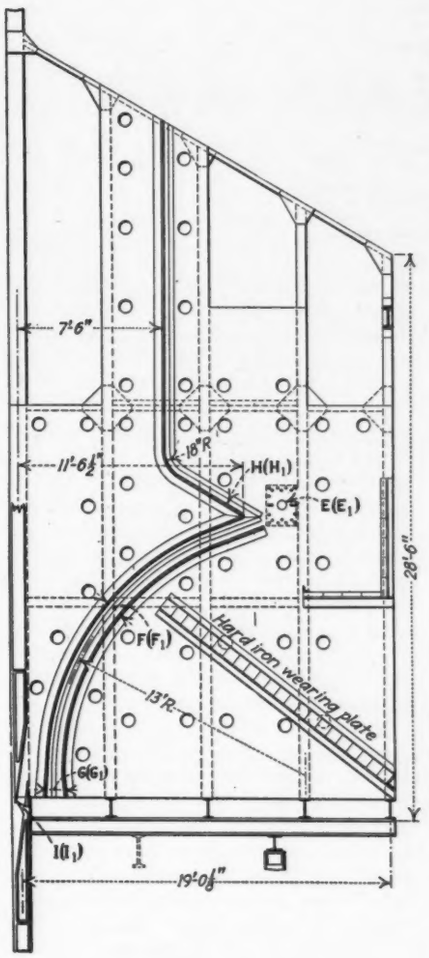


Fig. 8—Dumping mechanism at the Black Rock mine

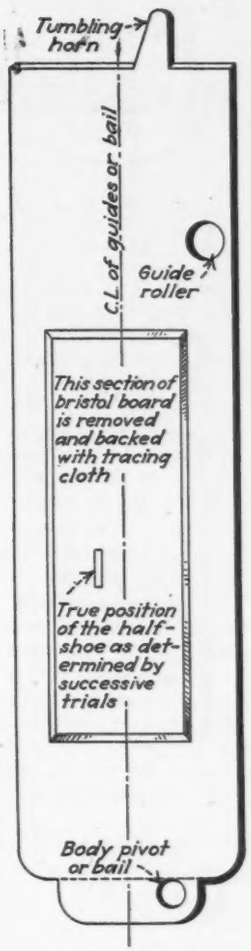
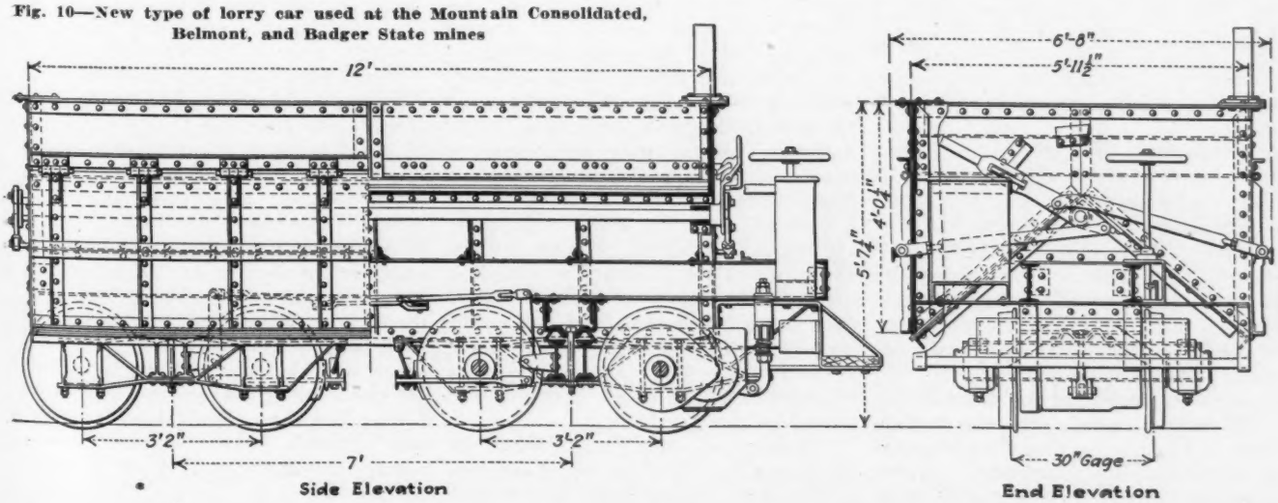

Tumbling horn
C.L. of guides or bail
Guide roller
This section of bristol board is removed and backed with tracing cloth
True position of the half-shoe as determined by successive trials
Body pivot or bail

Fig. 9 (at right)—Sketch of dummy skip used in graphically determining the position of half-shoe and radius of dumping arc

In conclusion, grateful acknowledgment is made to G. Mosher, mechanical superintendent, Butte & Superior Mining Company; P. F. Minister, assistant general manager, East Butte Copper Mining Company; L. L. Quigley, mill superintendent, Timber Butte mill, Anaconda Copper Mining Company; and F. C. Jaccard, mechanical superintendent, Anaconda Copper Mining Company, all of whom courteously reviewed both Parts I and II of this article.

Fig. 10—New type of lorry car used at the Mountain Consolidated, Belmont, and Badger State mines



SIXTY YEARS AGO

1870-1930

☞ THE FIRST *E.&M.J.*—For the first three years of its existence, *Engineering and Mining Journal* was known as the *American Journal of Mining*, the first issue under the new title appearing July 6, 1869. The change was accompanied by a broader scope in the articles, other branches of engineering not then being well represented in the technical press. From the editorial announcement we note: "Our eyes are open to the hard work before us necessary to build up a paper that will compare favorably with European models, in this, one of the most difficult branches of public journalism." The relation of American technical journalism to European has changed considerably since that time, thanks in large part to the co-operation that has been extended by the operators of American plants, who have in turn, of course, benefited.

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☞DEEP MINES—Though mining is one of the most ancient arts, our forbears did not get very far into the ground compared with the present accomplishment, with a dozen or more mines operating at depths of a mile and more. Sixty years ago the deepest mine in the United States was a silver mine in Nevada, a little over 1,200 ft. deep. A tin shaft in Cornwall was 2,112 ft. deep, a silver mine in Peru, 2,400 ft., and the Andreasberg silver-lead mine, in the Hartz Mountains, was 2,500 ft. deep. "A now abandoned mine in Bohemia reached the unparalleled depth of more than 3,000 ft."

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☞WHITE PINE, NEV.—Most of the mining excitement in 1869 and 1870 centered in the operations in the vicinity of White Pine, Nev., which was then having its initial boom because of the rich silver chloride deposits found there on Treasure Hill. In May, 1869, more than 300 companies had been incorporated in San Francisco, with a capital (fictitious) of over $100,000,000. About 250 of these were classed as wildcats. The method of flotation then used has undergone little change since: "*A* will purchase at White Pine half a dozen locations, good, bad, or indifferent—for all sell equally—for prices varying from $1,000 to $10,000 per claim. He comes to San Francisco and incorporates each under an attractive name, suggestive of the hoped-for richness, with a capital stock of from $250,000 to $1,000,000, and shares to the number of 10,000 each. A thousand shares are set aside as working capital and sold at prices varying from $5 to $10 per share—"unassessable"—that is the magic word—no more assessments—all dividends. Purchaser is told that in no event can he be called on for more money, and each share will soon be worth $100, but he never reflects that his interest is so small that if the ground represented by his ten shares were segregated he could cover it with his finger in most cases. In order to effect a speedy sale, a proportion of the shares remaining are *given* to gentlemen who will consent to act as trustees —successful men always being chosen so that every one may say: 'It must be a good thing or —— would not be in it.' By this means the promoters get back their investment in a few weeks, and have several thousand shares of stock left for speculative purposes." The number of shares mentioned—10,000—would seem to have been very modest indeed. We do things on a much grander scale in the twentieth century. There was the company known as the Pilot Copper Company, for instance, which owned eight claims in Mineral County, Nev., not many years ago. It was capitalized at seven and a half million dollars, and had over three million shares of treasury stock that it was willing to sell to all comers until the company finally went bankrupt. Its properties were sold at auction for $13,600 about ten years ago, as we remember it.

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☞SATIRE FOR the Editor—Correspondents apparently exhibited more politeness, or at least more subtlety, in writing to the Editor in the old days than now. In this day and age a choleric reader merely writes in to the following general effect: "Cancel my subscription. I am disgusted with your paper since you have sold out to the Interests." But in 1869, when the *American Journal of Mining*, as we were then called, published as a leading article a description of what was perhaps a half-baked idea for a method of propelling ships, a captious critic merely wrote in suggesting that the following be inserted thereafter at the top of the editorial column:

"Desirous of placing the *Journal* in the front wing of subversive, as opposed to what may be styled dogmatic mechanics, we have decided to put the first page at the service of mechanical free thinkers and inventors, whose projects have failed to gain a hearing in the papers of our more timid and orthodox contemporaries. To render a contribution eligible to this department of the paper, novelty will be regarded as the sole qualification. No writer need hesitate on account of the possible absurdity of his schemes, facts, or theories, if he believes in them himself.

"As an example of the kind of writing which we have now particularly in view, we refer to an article entitled 'A New Method of Propelling Vessels,' which appeared in a recent number, and from which may be inferred the kind of catholic tolerance which we are willing to extend to all shades of opinion and heresy. If anything more preposterous can be found in the annals of mechanical literature, it will be only necessary to send a copy to this office to insure its publication."

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☞EARLY Mining Education — The United States was formerly not so well provided with satisfactory mining schools as now, and in the 'sixties the Freiberg School of Mines, in Germany, was the mecca for all those young men who had set their hearts on being mining engineers and wanted to have the best education that the world afforded. In the April 7, 1869, issue of the *American Journal of Mining* is a list of all the American and British students who entered the Freiberg school from its foundation, in 1766, down to 1868. The first English student was J. Hawkins, who entered in 1786, and the first American was William H. Keating, of Philadelphia, who entered in 1819. Louis and Henry Janin, of New Orleans, Louis being the father of our well-known San Francisco friend, Charles Janin, entered in 1857; Rossiter W. Raymond, afterward editor of the *E.&M.J.*, entered in 1860; and Edward D. Peters, who was afterward professor of metallurgy at Harvard and the author of several authoritative books on the metallurgy of copper, went to Freiberg from Boston in 1865. About fifteen Americans a year used to go to Freiberg at that time. In the late 'sixties, however, the Columbia School of Mines began to afford Americans the facilities of a good mining education nearer home, and furthermore, of course, other American institutions of learning were also training budding engineers at that time. Columbia had only one mining graduate in 1867, but there were twenty such graduates in 1868, and in the following year the school had 93 students. Nowadays there are not more than five or ten graduates a year, but the course takes six years, and Columbia leaves the mass education of mining engineers to its Western competitors.

E. H. R.

The Andalusite Group of Minerals

A. V. Petar

Rare Metals and Non-Metals Division, U. S. Bureau of Mines

IN 1924, Bowen and Greig proved that sillimanite, as well as kyanite and andalusite, is changed upon heating into a compound $3Al_2O_3.2SiO_2$, with the liberation of silica. The compound was named "mullite." The free silica resulting from the decomposition of the natural mineral was said to be cristobalite. Just prior to the publication of these results the preparation and use of "artificial sillimanite" was studied at the Northwest Experiment Station of the U. S. Bureau of Mines, at Seattle, Wash. Results of laboratory tests on the use of this material as a refractory have been summarized by Wilson, Sims, and Schroeder, who say:

"Alumina-silica mixtures were prepared by fusing quartz, china clay, fireclay, and alumina in the electric furnace. When alumina is less than 68 per cent, crystalline sillimanite ($3Al_2O_3.2SiO_2$) with glass is produced. This material is not very resistant to loads at high temperatures, because of the early fusion and internal lubricating action of the glass surrounding the crystals. Above 68 per cent alumina, crystalline corundum appears and the glass is practically absent."

Commercial Development — Commercial utilization of this group of aluminum silicate minerals is a recent development. It had its beginnings during the World War in the search for a suitable insulating material for spark plugs. Synthetic porcelain insulators then available did not meet the demands placed upon them in war-time service in airplane engines. Acting upon findings of the Bureau of Standards, the Champion Porcelain Company tried to use artificial sillimanite in making porcelain, but found it impractical commercially. However, Dr. J. A. Jeffery, president of the company, believed that the problem could be solved by the use of natural sillimanite. A suitable deposit of andalusite was found in the Inyo Mountains in California, from which supplies have since been drawn.

In January, 1924, the Bureau of Mines undertook an investigation to determine the possibilities of using kyanite for the manufacture of refractories and high-tension electrical insulators. The study continued for more than two years. A preliminary report on the preparation of kyanite refractories was issued by H. C. Harrison, in which he described tests on bricks made of various mixes. The kyanite concentrate upon which most of the work was done contained about 93 per cent kyanite and 4 per cent quartz, with 3 per cent accessory minerals. In the bricks made it was found that 20 per cent was about the minimum amount of clay that would give the proper bond, and in some cases it was found desirable to add MgO in small amounts to promote a crystalline bond between the dissociated kyanite grains and the bonding material.

In a study of the electrical resistance of various ceramic materials at high temperatures, R. M. King found that "of the three minerals, kyanite, sillimanite, and andalusite, which have become noted for the formation of mullite in ceramic bodies, the kyanite sample tested seemed to be the best in electrical resistance, with sillimanite and andalusite next in order."

S. J. McDowell and E. J. Vachuska studied the effect of calcined kyanite in porcelain bodies and reported that mullite introduced as calcined kyanite, ground to a proper fineness, and introduced in feldspar and flint-clay porcelain bodies in amounts over 30 per cent, has the following tendencies on the physical properties of the bodies: "Increase in modulus of rupture; decrease in coefficient of expansion; increase in firing temperature required; increase in firing range; and color gradation from white to gray, a result of the presence of the iron-bearing accessory minerals. Thirty per cent or more of the material is required to produce marked changes in the body, owing to the fact that there is little or no seeding effect—that is, secondary mullite growth —from the kyanite grains. These apparently act merely as inert particles with desirable physical properties."

Harrison's work was supplemented by that of Vachuska and G. A. Bole, who found that the addition of 20 per cent or more kyanite tends to counteract the shrinkage of diaspore during continued use at high temperatures.

The first use of andalusite minerals was for making spark plugs, as has been mentioned, and that application is still the best known. The Champion Spark Plug Company and its subsidiary, the Champion Porcelain Company, later engaged in producing laboratory ware. Owning its own deposits in California and Nevada, this concern has ample supplies of raw material. In its catalog the claim is made that much less "sillimanite" ware than chemical porcelain is broken under the same conditions of use.

The use of mullite refractories in the glass industry has been described by W. A. Koehler as follows:

"The big field for mullite refractories at present is in the glass industry. With the introduction of glass-blowing machinery, glass tanks are operated at higher temperatures and at faster rates, so that the industry has been facing the problem of decreasing tank-block life. Glass-house refractories that come in contact with the molten glass have generally been limited to fireclay, or in special cases to porcelain, but mullite appears as a very promising material.

"Besides glass tank blocks, other fields for mullite refractories are glass pots, enamel furnaces, electric furnaces, muffles, piers, checkers in water-gas carbureters, and any parts of furnaces subjected to high temperatures, especially where high rigidity and nonshrinking and spalling characteristics are very desirable."

Uses of Kyanite—Recent tests indicate that, in firing electrical porcelain, saggers containing kyanite have a much longer life than those made from ordinary mixtures. Kyanite has likewise been used, more or less experimentally.

Abstracted from U. S. Bureau of Mines Information Circular No. 6255.

THE minerals andalusite, kyanite, and sillimanite have the same chemical composition ($Al_2O_3SiO_2$), but they differ in physical properties. Although all are employed in industry, they are often referred to indiscriminately as sillimanite. Another mineral closely related to this group is dumortierite.

in spark plugs, for refractory brick, in electrical porcelain and chinaware, and in glass and enamelware.

The Vitrefrax Company, of Los Angeles, produces kyanite from a very large deposit in Imperial County, Calif., for use in making ceramic materials for the porcelain, white ware, and electrical insulator trade and including super-refractories in the form of prepared grains, cements, and finished raw materials, together with a line of refractory brick and shapes for the glass industry.

Uses of Dumortierite—This is used with andalusite in making porcelain for spark plugs. The only commercial deposit now known is in Pershing County, Nev., and is owned and operated by the Champion Porcelain Company, of Detroit. The special qualifications of dumortierite for refractory use have been described by Walter S. Palmer as follows:

"The mineral forms a good basis for refractory material because of its high alumina content. It has important advantages over sillimanite, andalusite, and kyanite. Dumortierite burns to a practically pure white product. Dr. J. A. Jeffery informed me that it increases the toughness and electrical resistivity of porcelain and allows a greater temperature range in burning than does andalusite. It has a high fusion point, and porcelain made from a mixture of dumortierite and andalusite has a very low coefficient of expansion. Experimental ware made by the Champion Porcelain Company indicates that if sufficient dumortierite can be obtained its applications would multiply many fold. Greatly improved pyrometer tubes, chemical porcelain ware, and dishes have been made of it. The pyrometer tubes do not become porous or brittle after over a year's use in a kiln. Porcelain ware resists both mechanical shock and sudden changes in temperature much better than does the porcelain now in general use. By using the proper mixture of andalusite and dumortierite a high-grade refractory brick has been made by the Champion company for use in its own kilns. Bricks made of dumortierite alone gradually swell and those made of only andalusite sag, so that a proper mixture of the two yields a brick of exactly the right quality.

"The present known occurrence of commercial dumortierite is too limited to permit its employment in any field other than in the manufacture of spark-plug porcelain."

Manufacture of Mullite Refractories—Mullite refractories may be made by fusing alumina and silica in an electric furnace, but at present they are made principally from the natural aluminum silicates.

Kyanite, andalusite, and sillimanite are converted by heat to mullite and silica or to mullite and a siliceous liquid, but they are not interchangeable. The lowest temperature at which the alteration takes place is different for each mineral. Kyanite alters at the lowest temperature, sillimanite at the highest. In none, however, does the change take place sharply at any definite temperature; it progresses slowly over a considerable range. Dumortierite can be converted to mullite below 1,250 deg. C., and hence it too can be incorporated into white ware without precalcination. Mullite refractories may be manufactured either in the electric furnace or in kilns heated with gas or by means of oil.

Mining and Preparation—In California and Nevada, where andalusite and dumortierite respectively are produced by the Champion Porcelain Company, the material is mined selectively and hand-sorted. Both properties being situated some distance from a railroad, the selection of material is made carefully. At the California property, the sillimanite rock must be transported in sacks by burros down a steep trail 4½ miles long to the valley 6,000 ft. below, where it is placed upon motor trucks and hauled 3 miles farther to the railway siding at Shealy, Calif., and then by rail to Detroit. At the mine the large rocks are broken by hand into small pieces and placed in sacks at once, the sacks protecting the mineral from contamination during storage. The selection of the material is based upon frequent specific gravity tests made by means of a Jolly balance. At the railroad the sacks are dumped into carefully cleaned box cars.

Upon arrival at Detroit the material, as it is unloaded from each car, is spread or bedded horizontally in long parallel strips. Forty-five carloads form one large pile containing 2,000 tons. Three such piles are maintained; one pile serves as the source of the raw material while the next pile is being formed, and one is always kept in reserve. To get a uniform mixture the material is withdrawn from a pile along a face at right angles to the parallel strips or beds in which it was deposited, and a complete cut across the pile is made at each withdrawal, thus containing a segment of each carload.

The andalusite is first crushed in jaw crushers to less than 1 in. in diameter and is then stored in elevated bins from which it travels by gravity chutes into Hardinge mills, where it is ground by steel balls to 7 mesh or finer. After passing over magnetic separators to remove particles of iron from the ball mill, the ground material passes to a second conical mill lined with sillimanite and containing pebbles of sillimanite, in which it is ground to 100 mesh and finer. The resultant fine powder is transformed by screw conveyors to large hoppers holding approximately a ton, and these hoppers dump into storage bins.

The dumortierite from Nevada is also shipped to the Champion plant at Detroit and is treated in similar fashion to the andalusite.

Treatment of sillimanite for laboratory ware has been described in "The Story of Sillimanite Laboratory Ware" (Central Scientific Company, 1928).

Of the mullite products manufactured by the Vitrefrax Company, of Los Angeles, the highest grade, "Durox," is made by fusing a specially concentrated kyanite in the electric furnace at a temperature of about 3,000 deg. C. A cheaper grade of mullite is also manufactured by the company and sold under the name "California mullite."

In North Carolina, kyanite occurs massive and disseminated through schists. As the specific gravity of kyanite is roughly 3.6, or about the same as garnet, tests have indicated that it can be freed completely from the accompanying gangue by crushing to 28 mesh and in certain cases to much coarser sizes, which could be treated economically by means of jigs and tables.

Tests made at the Bureau of Mines experiment station at Rolla, Mo., about 1926, demonstrated the possibility of producing a concentrate containing under 2 per cent of free quartz and the elimination also of most of the heavier gangue material.

Production—In the United States the commercial production of these aluminum silicate minerals apparently began in 1920 and has progressed more or less steadily since that year. Practically no statistics are available, however, for production in this country. In California, from 1922 to 1926, inclusive, the total production of the sillimanite group of minerals amounted to 9,394 tons, valued at $301,790. In Nevada, figures of production are not available, since there is only one producer. The Champion Porcelain Company, however, has operated its dumortierite property fairly steadily since starting operations in the latter part of 1925. In Virginia, the McLanahan-Watkins Company, at Charlotte Court House, has operated intermittently. In North Carolina, a few tons have been mined from time to time, chiefly for experimental purposes.

Considerable experimental work directed toward the utilization of kyanite has been done in Germany in recent years, as, for example, by Heinrich Koppers at Essen, but outside of the United States the only production—at least on an extensive scale—appears to have come from British India. In 1928, 2,241 tons of kyanite, valued at £2,509, was produced in the Singhbhum district, as compared with 4,425 tons, valued at £1,866, in 1927. The greater part of this production came from the Lapso Hill mines, in Kharsawan State—1,896 tons in 1928 and 3,665 tons in 1927. A smaller quantity, 345 tons, was produced from E. O. Murray's mines, at Ghagidih. The principal producer of kyanite in India is said to be the Indian Copper Corporation, which produces the min-

eral at its Lapsa Buru mine. The material is marketed in England by the P. B. Sillimanite Company, Ltd.

A certain amount of sillimanite shipped from India was reported in the statistics as corundum, with which it is associated, and it was not until 1921 that material from the Khasi Hills was known to contain sillimanite. Complaints from purchasers in London because of the lack of hardness of a consignment led to a chemical and microscopical examination, which revealed in one of the brands over 35 per cent of silica and a hardness of about 6.5 instead of 9. At the same time, however, it was pointed out that as a refractory, especially for glass furnace use, sillimanite was of greater value than corundum. The Khasia Mines, Ltd., went into liquidation in 1922, and stocks of the sillimanite-corundum rock on hand in London have been marketed. A few years later H. A. Golwynne, of New York, purchased a sillimanite property in India, which was subsequently operated, and it is reported that sillimanite brick has been produced from this Indian material and offered on the American market at $1 per brick.

Occurrence of Sillimanite — In the United States many scattered occurrences of sillimanite have been reported, but no production of consequence has been made. The products of the Champion Porcelain Company are marketed under the trade name "sillimanite," but the principal ingredients are andalusite and dumortierite.

The largest known deposits of natural sillimanite are in India, in Assam, in the neighborhood of Sona Pahar, north of the village of Nongmaweit, in Nongstoin State, and in Rewa State, Central India, near Pipra. At the former deposit, which is on the Khasi Hills Plateau, it has been estimated that 83,000 tons is available, including float ore. The deposits consist mainly of massive sillimanite, with a little corundum. The deposits in Assam are very inaccessible, being reached by motor truck from Gauhati 36 miles west of Boko, by bullock cart 12 miles south to Haima at the foot of the Khasi Hills, and finally a march south into the hills for 23 miles. A branch line from the proposed new railway along the south bank of the Brahmaputra River has recently been contemplated, which will provide transportation and thus make the deposits more accessible.

The deposit in Rewa is estimated to contain 1,000,000 tons of poor material and 100,000 tons of higher grade sillimanite. The deposit is associated with sillimanite schists and pyroxene-bearing rocks, and separation of high-grade sillimanite is difficult. Here, too, transportation is a handicap, as the material must be carried about 120 miles by bullock pack to Mirzapur for rail shipment to Calcutta.

A smaller occurrence of corundum and sillimanite has been noted in the Bhandara district of the Central Provinces, but it does not appear to be important.

Occurrence of Andalusite—The largest known deposit of andalusite is that of the Champion Porcelain Company, in the White Mountains of the Inyo Range, in Mono County, Calif. It is located at an elevation of 10,000 ft. and is said to contain large reserves. Occurrences have also been noted in South Dakota, in the central Black Hills, in a belt of pegmatitic masses extending from near Oreville northeastward to Summit Peak. During 1925, trial lots amounting to about 16 tons, valued at $635, were shipped by three producers —the Black Hills Mining Company; George B. Grant, of Custer; and Mills Bros., of Hill City. Though the material was suitable for the manufacture of spark plugs, the prospects do not appear to be attractive enough to insure large-scale production.

Deposits of andalusite have been reported in Nova Scotia, but so far as known not worked commercially. The mineral has also been found in large white lumps showing crystal faces at Chenderdang, British Malaya, and with pinkish mica and quartz as a vein in limestone at Gopeng. The variety known as chiastolite has been found in small quantity in several other scattered localities.

Occurrence of Kyanite—Kyanite occurs in varying quantities in Arizona, California, Georgia, Massachusetts, New Mexico, North Carolina, Pennsylvania, Virginia, and Wyoming. The largest production has been from California, but substantial quantities appear to be available in North Carolina, Virginia, and other states. In California, an extensive deposit occurs 3 miles from Ogilby at 500 ft. elevation, and is operated by the Vitrefrax Company. The first discovery was made in a low, rounded hill one-eighth mile wide by one-half mile long, and probably consists of 25 per cent kyanite in a matrix of quartz. One-quarter of a mile farther east, a prominent vein outcrops for one-half mile in length, at the foot of the Cargo Muchacho range. The vein, which occurs in a mica schist, is nearly vertical and varies from 10 to 200 ft. in width. Open cuts and tunnels have been made along the deposit for a distance of over 500 ft. along the strike. The most extensive showing has been found on the north end of the deposit. Here it outcrops for over 200 ft. in width. Quartz is the gangue mineral, while small amounts of black tourmaline occur throughout the vein material. On the south end of the deposit, both walls of the vein have a selvage of talc.

Extensive deposits of kyanite are reported in North Carolina, principally in Yancey County, where it occurs in large quantities in a schist on the north end of the Black Mountain range. In this particular locality it makes up 10 to 40 per cent of the rock mass, the accessory minerals being chiefly quartz, mica, and garnet, with smaller amounts of tourmaline, staurolite, and corundum. At one property a process is said to have been perfected which gives a concentrate carrying 98 per cent of kyanite. Other occurrences in Yancey County noted by Bryson are south of Micaville, on Cattail Mountain, and near Black Mountain. At the latter locality the kyanite has a massive structure, showing little schistosity. Other occurrences are in Clay, Iredell, Haywood, Cherokee, Graham, Caldwell, Jackson, Mitchell, Avery, and Wilkes counties.

In Virginia a deposit of kyanite near Charlotte Court House has been worked for several years by the McLanahan-Watkins Company, which has operated a concentration plant. The mineral is at least in part in a quartzite, and is said to be in large quantity. The Virginia kyanite is accompanied by more or less rutile.

There are a number of kyanite deposits in the eastern part of India, in Bihar and Orissa. The largest are in the Province of Singhbhum, and have been described by Sir Edwin Pascoe, who says that the largest is that at Lapsa Buru, where the débris alone would probably provide a minimum of 234,000 tons of kyanite rock and the actual quantity may be ten times this amount.

Occurrence of Dumortierite—Dumortierite has been reported in Arizona, California, Colorado, Nevada, New Mexico, New York, and Washington, but the only deposit of commercial importance appears to be in Nevada. There are four occurrences of dumortierite in Nevada. The largest of these, in Humboldt Queen Canyon, 6 miles east of Oreana, Pershing County, was purchased by the Champion Porcelain Company in October, 1925. As previously noted, this company employs dumortierite mixed with andalusite in the manufacture of spark-plug porcelain.

Dumortierite has been reported from many parts of the world, notably France, German Silesia, Switzerland, Czechoslovakia, the Russian Urals, southern Norway, Scotland, Cornwall in England, Madagascar, Argentina, Brazil, Canada, and Mexico. In each place the mineral seems to be in comparatively small quantity.

Imports and Exports—Indian sillimanite has been on the American market since about 1923 and is said to be of good quality. Imports of sillimanite, however, are not listed separately, and no reliable estimates are available as to the quantity received from India or other countries. Small shipments of American kyanite appear to have been made from time to time to Europe, but chiefly for experimental purposes, and no regular trade has yet developed.

Markets and Prices—Demand for the four minerals has not been extensive.

The largest consumers have their own deposits, which have apparently been of sufficient size to satisfy their needs. However, there is reason to believe that a producer who could guarantee an assured tonnage of kyanite, reasonably free from mica, garnet, and similarly undesirable impurities, would be able to secure orders promptly for 10,000 to 15,000 tons and perhaps considerably more annually. Since much of this business would have to be taken in competition with other refractory raw materials, the price would doubtless be determined on the basis of actual performance. The foregoing estimated tonnage is based on an assumed price of $15 to $20 delivered at Pennsylvania plants.

The price of sillimanite in England has recently been reduced from £14 to £11 per ton. Indian kyanite is marketed by the Indian Copper Corporation at Rs. 36 per ton f.o.r. Amda, Bengal-Nagpur Railway line.

The Bureau of Mines attempts to keep in touch with producers and buyers of the various minerals and metals, so that it may help producers to find a market for their material or may aid buyers and users in locating sources of supply of the ores in which they are interested. The names of the following persons and firms have come to the attention of the Bureau as being interested in the group of minerals covered in this report. Although the list is by no means complete, it is hoped that it may prove helpful to persons engaged in the industry.

POSSIBLE PRODUCERS AND DEALERS

H. M. Calhoun, Elkin, N. C.

J. H. Tate, Marion, N. C.

J. A. Pollard, Burnsville, N. C.

Col. D. W. Adams, Old Fort, N. C.

A. F. Holcomb, Hamptonville, N. C.

Joel T. Watkins, Charlotte Court House, Va.

J. D. Roberts, Ball Ground, Ga.

William J. Hanley, Ogilby, Calif.

Vitrefrax Company, Los Angeles, Calif.

J. Frank Beck, Atlanta, Ga.

Parco Development Company, Parco, Wyo.

Charlotte Chemical Laboratories, Charlotte, N. C.

Mineral Products Sales Corporation, 135 Front St., New York.

Varlacoid Chemical Company, 15 Moore St., New York.

Champion Porcelain Company, Detroit, Mich.

George B. Grant, Custer, S. D.

Pettit & Coates, Hill City, S. D.

POSSIBLE BUYERS

H. C. Bugbird Company, 58 Pearl St., New York.

Exolon Company, Commercial Ave. and Erie R.R., Blasdell, N. Y.

A. D. Mackay, 26 Cortlandt St., New York.

National Sales Corporation, 31-35 E. 13th St., Cincinnati, Ohio.

The Findlay Clay Products Company, Washington, Pa.

A. C. Spark Plug Company, Flint, Mich.

Harbison-Walker Refractories Company, Pittsburgh, Pa.

Corning Glass Company, Corning, N. Y.

U. S. Refractories Corporation, Mount Union, Pa.

General Refractories Company, 117 S. 16th St., Philadelphia, Pa.

E. J. Lavino, Bullitt Building, Philadelphia, Pa.

Upkeep of Electric Locomotives

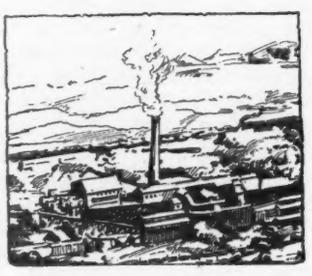
J. S. Dean

Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

ELECTRIC locomotives are essential in connection with the economic handling of ore in modernized mines. The problem of their upkeep should therefore be of vital interest to the men directly responsible for maintenance. The tonnage output of mines depends largely on the reliability of the locomotives. They should, in consequence, be kept in good repair, to minimize breakdowns and to insure continuous operation.

The shop force in charge of the maintenance of the locomotive equipment should be thoroughly organized to keep operating costs down to a minimum and at the same time turn out the maximum amount of work in their repair and overhauling shops. Various men or groups of men should be assigned to specific duties, for which they should be held responsible by one in charge, who in turn should report to the electrical superintendent in charge of maintenance work. This arrangement will avoid duplication of work and any confusion that might result in carrying out orders and reporting troubles. The head of the electrical and maintenance department will be better able to keep in close touch with all lines of his work by direct contact with the heads of the different branches of his organization.

A system of keeping simple and accurate records of locomotive equipment, to assist the superintendent to direct more efficiently the work of maintaining the locomotives, is well worth the trouble and expense involved. Such records keep the management advised as to such details as troubles, repairs, and cost relating to the upkeep of the locomotive equipment. In general, these records should include, among other details, motor armature troubles, locomotive failures, wheel and axle or truck life, tonnage hauled by each locomotive, cost of repairs, and cost of locomotive upkeep per ton of ore produced



Careful and systematic inspection of mine locomotives is of great importance. If carried out regularly it will tend to prevent failures and breakdowns in service and be a great factor in increasing the tonnage output of ore. A schedule of inspection somewhat along the following lines is suggested for consideration.

1. *Daily Inspection*—Brake rigging should be checked; worn brake shoes should be replaced; motor frame and axle cap bolts should be tightened; wiring, covers, controllers, headlights, sanders, and all details should be inspected for any loose or defective parts.

2. *Light Inspection*—A light inspection should be given each locomotive about every 30 days. At this time tighten all bolts carefully and adjust the brakes and brake rigging. Remove covers from the motors and inspect the brushholders, carbons, and commutators. Check the armature and axle bearing wear; also, the controllers, headlights, wiring, and all details of the locomotive. Make the necessary replacements of damaged or worn parts found during this inspection.

3. *Heavy Inspection* — About every two years, take all the equipment off the locomotive and give the parts a general overhauling. Motors and controllers should be thoroughly cleaned, repaired, and tested before putting them back in service. Revamp and put in good operating condition the mechanical parts and all detail electrical apparatus of the locomotive.

Smelter Equipment Trends

Indicated by recent additions and improvements at the El Paso plant of American Smelting & Refining, as described by

E. R. Marble

Superintendent

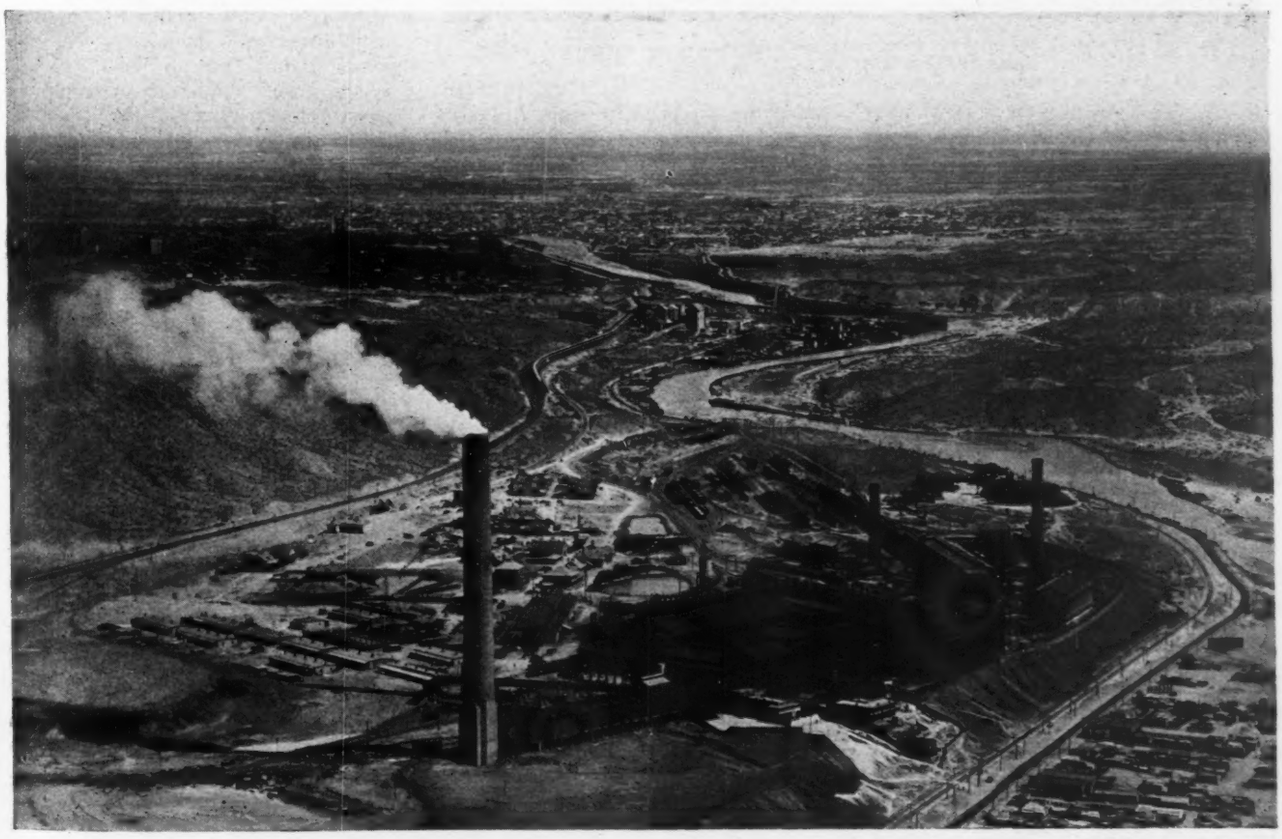
THE EL PASO plant of the American Smelting & Refining Company has, during the last year, made several additions and improvements to its equipment, notably the installation for burning natural gas as fuel throughout the plant.

In the lead department a Dwight & Lloyd sinter crushing plant is now under construction for crushing the once roasted product. The sinter from three Dwight & Lloyds will discharge onto a pan conveyor carrying the material to corrugated rolls crushing to 3-in. size. A second pan conveyor carries the sinter to rolls set to deliver a ¼-in. final product which will be elevated to a storage tank. As needed, the crushed sinter will be conveyed to the second roaster mixing table.

A dross reverberatory is being constructed to handle the lead department dross. The copper in the charge at the plant averages more than 3 per cent, and the resmelting of the dross from the lead kettles keeps one blast furnace busy most of the time. The reverberatory will be much more convenient, being situated adjacent to the drossing kettles, and will make a product more suitable for transfer to the copper department.

Of the six lead blast furnaces now installed, two will be retained for the present, and the other four torn down. Two new furnaces are being built with redesigned crucible, jackets, and tuyères. The present blast furnaces have two tiers of jackets, and tuyère sacks are used. The new jackets will be single jackets of the same height as the present two tiers, and the tuyère sacks will be eliminated.

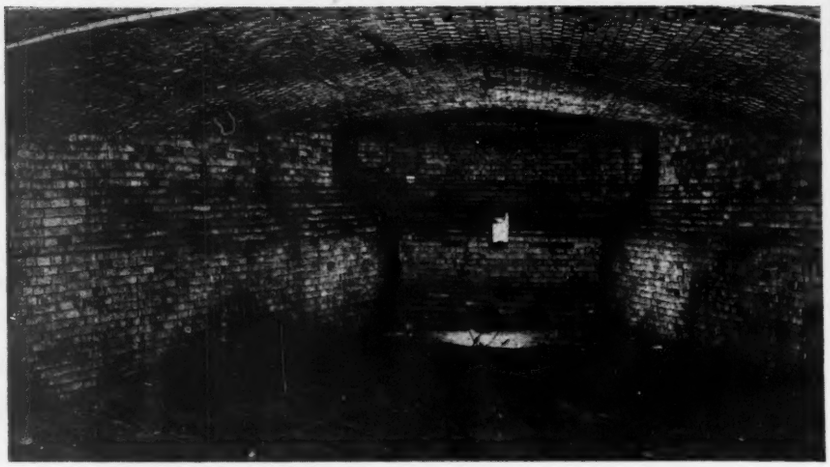
In the copper department a Cottrell plant of the plate type has recently been placed in successful operation, handling all gases passing to the main stack. The treater consists of six chambers of four sections each, with a dampering arrangement whereby half of the chambers can be separated from the other half. Gases from the reverberatories and roasters pass normally through half of the treater. Those from the converters pass through the other half. The plant functioned successfully from the start, except for a low lead recovery on the converter side. To improve this a conditioning plant has been built to give the gas the necessary conductivity by neutralizing the basic zinc and lead fumes in the gases. To minimize infiltration of cold air through the converter hoods, the three converters are being equipped with tighter hoods after



Air view of El Paso smelter, with the Rio Grande and the cities of El Paso and Juarez in the distance

the design found satisfactory at the Garfield plant. These hoods are largely of welded plate construction.

The natural-gas installation is, perhaps, of more interest than any other development at the plant in recent years. Natural gas serving El Paso comes from Jal, N. M., being transported in a 16-in. line 218 miles long. Gas pressure at the wells is 1,450 lb., which is reduced to 300 lb. before passing into the line. The pressure upon arriving at El Paso is 220 lb.; subsequently it is cut to about 70 lb. for distribution to the industries. An 8-in. line enters the smelter metering station, where the pressure is reduced to 35 lb. for distribution about the plant. Gas is measured at the station by meters of wide range, first passing through the gas company's meters and then through the smelter check meters. The plant is served by three distributing lines, which can be interconnected later if the service becomes heavier than at present.

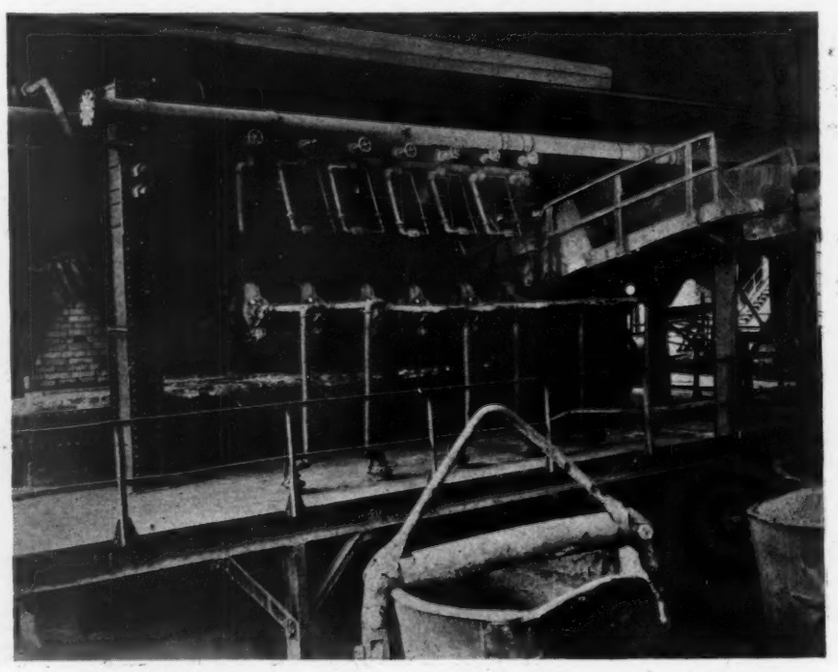


Front end of reverberatory, showing typical El Paso construction

Interior of furnace taken from firing end, showing protective magnesite insert along the side wall at top of the bath

The major user of gas is the copper reverberatory. This furnace has six surface-combustion two-stage-velocity-type burners using gas at 22½ lb., the gas stream sucking in the necessary air for complete combustion, on the principle of an inspirator. These burners are shown on the front cover of this issue. Little difficulty was experienced in the use of natural gas on the reverberatory, aside from troubles during the first week of its use. The first velocity stage of the burner sucks a portion of the air through the back shutter of the burner, the rest being drawn through the shutter on the bridge wall, placed between the first and second stages. The draft of the furnace had been expected to assist in drawing the air through the bridge-wall shutter, but actually no air was obtained by this means. Therefore, it became necessary to decrease the diameter of the throat of the first velocity stage, thereby increasing the velocity of the gas sufficiently to permit it to entrain air at the bridge-wall shutter. This necessitated raising the gas pressure from 10 lb., as originally contemplated, to 22½ lb., which pressure is used now. The second stage port was originally a brick orifice 13¾-in. in diameter set in the bridge wall, but as the first furnace campaign on gas progressed, the bridge wall and port gradually burned back, so that the proper proportioning of gas and air for combustion was not secured. Water-cooled ports were therefore installed at the time the furnace was next down for repair. These ports caused pre-ignition difficulties, which were corrected by extending the nose of the primary port halfway into the secondary port.

Before the use of natural gas on the reverberatory it was considered vitally necessary that the gas flame have some degree of luminosity in order that the heat transfer rate be sufficiently rapid to smelt the charge economically. It was assumed that if gas of itself did not give the proper luminosity it would be necessary to carburet the flame with a small percentage of fuel oil to secure



Natural-gas burners on No. 1 center-charged water-jacketed furnace

the desired result. The gas flame proved to be absolutely non-luminous, so that the furnace interior can be inspected in all its minutest detail while under fire. Contrary to expectations, carburetion has not been necessary.

The desire of all smelter men is to have a fuel that can be controlled absolutely as to quantity, and to know that each burner is securing its proportion of the total used. Natural gas seems to fulfill this desire better than any other fuel.

At the Wedge roasters each furnace is equipped with two burners, one being 6 in. and the other 4 in. in size. This gives flexibility in firing; in starting a cold roaster both burners, must be used, whereas for normal operation the choice of the two sizes of burners is offered. For some time over 500 tons of charge per roaster day has been calcined.

The two 150-ton copper anode furnaces are also equipped for burning gas, and no trouble has been experienced in its use.

The Dwight & Lloyd machine on second roast did not work well with a simple pipe gas burner, a brick-lined muffle equipped with seven small gas burners being necessary for proper ignition. Other smaller users of fuel, such as assay muffles, laboratory hot plates, and miscellaneous heaters, are being equipped for gas, so that fuel oil has been almost entirely displaced throughout the plant.

Current Leakage a Cause of Misfires

IN LARGE-SCALE blasting it is customary to fire many shots simultaneously. Ordinarily, electric detonators are used and are connected in series or in parallel groups of series and are fired either from a power circuit or by means of portable, hand-operated blasting machines.

Most portable blasting machines are designed to fire electric detonators in series. Trouble is sometimes experienced from misfires when firing with such machines, and the shots that fail to fire are usually of a group in the center of the series. Various explanations of the cause of the failures have been given. Technical Paper 471, recently issued by the U. S. Bureau of Mines, covers tests, made at the Pittsburgh Experiment Station of the Bureau, that may be helpful in explaining the probable cause and in preventing such misfires. The report concludes as follows:

If all of the detonators of a series circuit are in wet holes and the leg wires are not specially protected, there will probably be uniform leakage contact with the earth. If this is so, the greater part of the leakage will be out from the leg wires near one end of the series and in through the leg wires near the other end; the center detonators will have a uniformly lower current through them and will misfire. The detonators near one end will fire because not much leakage has occurred; those near the other end will fire because much of the firing current has returned to the circuit. The center detonators will misfire, not necessarily because the current is too small to fire an electric detonator (tests showed that some misfires received more than 2 amp. through their bridge wires), but because the current through them does not fire them before the firing of the end detonators has opened the circuit. The number of misfires will depend upon the amount and uniformity of the leakage, the number of detonators in the series, the strength of the firing current, and the relative sensitivity of the detonators.

If there is 20 per cent or more leakage in a series circuit, misfires should be expected, irrespective of the number of detonators in the series.

Misfires may occur when no leakage exists if the flow of current is not sufficient to fire all of the detonators of the series before the firing of the more sensitive ones opens the circuit.

When firing is done with portable hand-operated blasting machines misfires may occur even though the leakage is small. On the other hand, if a machine is overloaded—that is, if there are too many detonators in the circuit—misfires may occur even though there is no leakage.

Any misfire is dangerous and costly; therefore the problem of one who is making an important blast is really not to limit the number of misfires to a minimum but to prevent any.

The tests showed that cotton-covered enamel wire is effective in preventing leakage, provided there is sufficient firing current (at least 1½ amp.), but leg wires that were not enameled allowed serious leakage in every test.

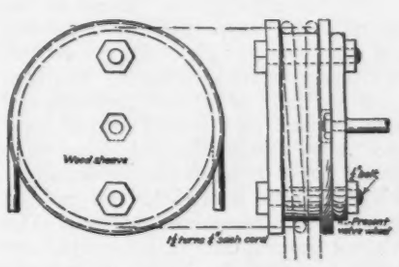
In a few instances of possible leakage, where the number of holes is limited and a battery or an ungrounded power supply that will insure each detonator receiving at least 1½ amp. firing current is available, misfires may be prevented effectively by connecting all detonators in parallel. Under leakage conditions where the straight parallel connection is not feasible, detonators with covered enameled leg wires should be used.

Other less effective precautions that may be helpful in preventing misfires when very little leakage is present are as follows: Use a firing supply of sufficient voltage to send a current of 3 amp. or more through the circuit; limit the number of detonators in each series circuit by using combinations of parallel and series connections; use new detonators that are all of one type and manufacture; and fire as soon as practicable after the loading and connecting operations are finished.

The change in the resistance of a circuit due to leakage is a correct measure of the amount of the leakage. Such measurements should be made by means of an ammeter and voltmeter using alternating current and limiting the current flow to no more than 0.20 amp. Measurements by means of a bridge, testing galvanometer, or other direct-current methods are not reliable indicators of leakage, because they are subject to polarization effects.

Operating Overhead Valves From the Floor

IN MOST plants certain small valves must be opened or closed frequently, or perhaps regulated many times during the course of the day. Occasionally these valves cannot be reached from the floor, and a ladder must be used. The method of extending the stem by means of a long rod with a forked end to fit into the handwheel is common, but the stem of the valve cannot always be made to point downward or at an angle so that this expedient can be employed. The illustration shows another way of doing this where the valves are placed with the stem horizontal. A wooden sheave is bolted to the handwheel of the valve, and sash cord is wrapped around the sheave and extended to within reaching distance of the operating floor.—B. Myers, in *Power*.



Operating sheave attached to valve wheel

Supply and Demand, or Stabilization?

THE failure of the attempt to maintain the price of copper at 18c. is seen by Mr. Finlay as proof that inflexible "stabilization" is impracticable. Brilliantly he expounds the doctrine of supply and demand—old, perhaps, but still worthy of serious consideration as a factor of importance in any study of the economics of industry.

J. R. Finlay

THE attempted "stabilization" of copper at 18c. a pound, which excited considerable controversy, is now a thing of the past; but in certain quarters the belief apparently exists that the only difficulty with stabilization is the choice of a price. Most commentators have attacked the stabilized copper price (18c.) as too high — not the principle of stabilization.

I should like to take exception to that argument. I object to the principle of stabilization; indeed, I do not believe there is any such thing, either in principle or in fact. Gold is supposed to be stabilized, but all it means is that a certain fraction of an ounce of gold is called a dollar. All the concerted powers on earth cannot dictate what the gold dollar shall buy. Within my recollection it has bought sometimes three bushels of wheat, at other times half a bushel; it has bought two-and-a-half ounces of silver, then two-thirds of an ounce; and so on *ad infinitum*. I could not add anything more convincing by repeating a long list of the same kind of examples.

The "principle" of stabilization is, I believe, a mischievous fallacy as old as the hills, which tries to appear from time to time clad in a new apparel of plausibility. It is, in reality, the theory of monopoly; if it is justified for one commodity it should be justified for all. Then we should substitute for an open market an inconceivable tangle of interests, each supporting by argument and connivance its claim for a "fair and just return on its investment," and then come logically to a vast authority on such matters that would declare what each man should do and what each should have: communism. Human intelligence and information do not go far enough to run things that way. The greatest governments of the world have failed to establish for very long the value of a pound of rubber, a pound of coffee, a bushel of wheat, or an ounce of silver. Sooner or later the scheme falls of its own weight; for, if the price set is high enough, presently more is produced than can be sold, and the price has to be marked down for the double purpose of discouraging production and encouraging consumption; or, conversely, if the price set is too low, not enough will be produced to satisfy the market, and the price will be raised, if necessary by subterfuge. In either case things wind up where they started, after the expenditure of a vast amount of futile effort and unproductive scheming that aggravate the disorder they were designed to cure. A monopoly based on superior efficiency sometimes arises, such as, I believe, the Standard Oil, but it eventually has to face popular mistrust and finally public opposition.

Thus monopoly, either by concert or by direct ownership, has been found in the long run to be neither profitable nor desirable. Its apparent advantages turn out to be the effect of short-sightedness; illusory.

In stating things this way I shall probably be smiled at in certain circles as an old fogy. Have I not learned that competition is a thing of the past? That community of interest is much superior? That supply and demand is the exploded theory of the antiquated Manchester School? Yes, I have heard of these discoveries, but I have learned nothing from them except to class them with the discovery of perpetual motion; the prime factor is left out. Competition is the universal law of life—animal or vegetable. A man's place in the world is determined by his power to compete and by the extent to which he sees fit to use that power; and what applies to the individual applies with equal certitude to organizations, including nations.

The one stable element in business is human nature, in which competition is imbedded, not by desire or argument, but by necessity; and human nature is as stable as the level of the ocean (although nothing seems more unstable than water), which cannot be lowered at one place except by raising it at all other places. So competition, if obstructed in one direction, is merely intensified in some other; if the market place is made useless by a communistic state, the man who would be a captain of industry will turn his attention to politics; and, instead of exacting efficiency from employees he will exert himself to find places for henchmen; and those employees, instead of competing for the best jobs by doing the best work, will compete in currying favor. As to which state of affairs would be better I leave to anyone's choice and to his knowledge of history.

I think, then, that any defense of "stabilization" of prices by argument and agreement must in the long run prove futile, for the simple reason that prices are not to be fixed that way, no matter who tries. The strongest governments can't do it: witness the present "stabilization" of wheat. One rather amusing illustration of stabilization is that of the French *livre* or franc, which started out as a pound of silver worth about $16, but through the successive attempts of the government to make the people take first debased currency, and later paper money, often under the direct threats of punishment if they refused, this *livre* at its latest "stabilization" has been fixed at 4c.—one four-hundredth part of the quantity indicated by its name!

Those who believe that competition and supply and demand govern commerce and industry will contend that the real stabilizer is that law and that

the real principle of the schemes called by the name of "stabilization" is merely to dodge that law. They will also admit that, if these schemes really work, their authors have discovered a new set of economic principles and have made themselves the pioneers of a new prosperity.

In the working of supply and demand, the market for a given commodity belongs to the strongest competitors. They do not curtail; they leave that to those producers, called marginal, whose position is not secure. As the French proverb says (perhaps cynically):

"La raison du plus fort
Est toujours la meilleure."

("The reason of the strongest is always the best.")

Let us remind ourselves once more that we are talking about *stability*, not about prices. The ousting of the weak and the inefficient comes through the lowering of prices to a point below normal, but the consumer immediately recognizes that the cure is effective, that the price is sound. Optimism returns from the mere belief that the worst is over.

The fundamental trouble with schemes that go by the name of "stabilization" is that they invariably try to set a price that, in the guise of being fair to the industry as a whole is above the point where the inferior competitors are discouraged—that is, above the basic or real market. Who ever heard of a commodity being stabilized *below* the market? If the price hit upon happens for the moment (and it can only be for a moment) to concur with the market, it is a colorless affair which attracts no attention and is not worth attention.

A "stabilization," then, is always a speculation to see if its authors cannot force or persuade the world to take their commodity at the price they see fit to set, and as much of it as it would take at any other price. Strength is to lie, not in superior efficiency, but in an association of conspirators. It is soon regarded with resentment and suspicion; the brains of the world are enlisted to discredit and undermine it. The scheme becomes, most unacceptably to its promoters, a sort of campaign of altruism; taking the market from the strong to hand it over to the weak. Marginal producers who find the price attractive, or worth while, are bound to make as much hay as they can while the sun of stabilization shines. In this way the term is found to contradict itself; for those who desire stability will find speculation and altruism but poor reeds to lean on.

Thus I think that the term "stabilization" as it has been used is a false one: it means price fixing, or rather price raising by manipulation. These last terms do not sound so well; they have been discredited over and over again. Real stability is always in the wise conduct of business.

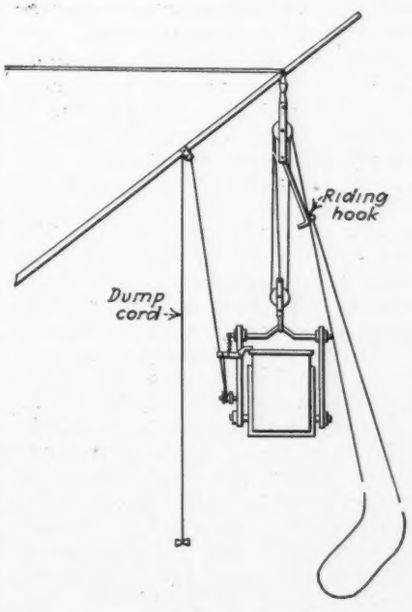
A Prospector's Hoist

RECENTLY I saw a hand hoisting rig that was new to me, and which, in some respects, was better than the usual windlass and bucket for shallow shafts, writes J. B. Paxton, of Wagoner, Ariz. It was operated entirely by one man at the shaft bottom, dumped the muck clear of the shaft, and was inexpensive to make. The shaft in which I saw the rig used was down 25 ft., the walls were good, and no timber had been needed.

A mast and boom, made from two 10-ft. saplings, were set up near the shaft. The boom was fitted at the lower end with an iron shoe, which was bolted to a bracket, fastened to the mast. This arrangement allowed the boom to move sideways between two of the guy ropes. A rope, which was tied to the upper end of the boom and wound around the mast for a couple of turns and fastened, held the boom at the proper height and caused the boom to swing from the shaft to the dump.

A bucket, holding about 1 cu.ft., was made from a carbide drum. This was reinforced by strap iron, riveted around the upper edge and the bottom. The sides were strengthened by a U-shaped piece of 3x¼-in. iron, also riveted. A bale, fastened to bolts in the U-strap near the bottom, permitted the bucket to be dumped by opening the dumping latch. A double block was tied to the upper end of the boom, and a "riding hook" hung from the bottom rivet of the block. A single block was hooked to the bale of the bucket, and a ⅜-in. rope was used. The rope was long enough so that the loose end was tied to the riding hook; this provided a method of operating the hook and also of holding the boom in a stationary position when raising and lowering the bucket.

When operating the hoist, the miner at the shaft bottom swung the boom and empty bucket from the dump to a point over the shaft by pulling on the hoisting rope. The bucket was then raised an inch or so, and the rope held with one hand. Meanwhile with the other hand, the riding hook was drawn back from the bale by the rope fastened to it, and the rope made fast to a short piece of drill steel that was set in the wall of the shaft. The bucket was then lowered and filled with muck, the bale set in position and locked, and the bucket hoisted until the two blocks touched. Holding the rope with one hand, the rope to the riding hook was loosened, allowing the hook to swing under the bale, when, by easing off on the hoisting rope, the loaded bucket was left hanging on the hook ready to travel. Making sure that the ropes were all clear, the miner let the boom and bucket swing, holding the dump cord in one hand. A knot tied in the dump cord indicated when the bucket had reached the dump. A slight pull opened the latch and dumped the bucket. The average time of operation was five minutes per load.



Arrangement of prospector's hand hoist

The operation was easily performed, and, unless the miner unintentionally stood on the trip cord, there wasn't any danger that the bucket might dump while over the shaft. He always stood in the farthest corner of the shaft when hoisting, and therefore was in the clear when the bucket dumped. In the accompanying sketch, the bucket is shown swung one quarter of a turn from its actual position when being hoisted.

COMMENT AND CRITICISM

The Threat of Unemployment

To the Editor of "E.&M.J.":

An interesting question is: "Can the mining industry do anything for itself to nullify the threat of unemployment or to minimize its dangers?" Not only the economist but every business man, whether employer or employee, acknowledges that the steady running of an industry is desirable. The question arises whether such a state of affairs is possible when the demand for a product must vary from time to time. So far as mining is concerned, the best that a company can do during hard times is to continue operating, even though at a small loss; this plan is especially applicable when a depression is apparently only temporary. An important factor, the importance of which grows with increasing distance from sources of supplies, technical assistance, and unskilled labor, is to keep intact an organization that has proved to be competent. As the mining industry, like any other, is subject to its ups and downs, such action is possible only through the establishment of a reserve fund. The first duty of any enterprise, it appears to me, is to create such an emergency fund before the declaration of any dividend, and to add to that fund while the enterprise is profitable. This is a sound policy. Nevertheless, owing to the desire to pay a high dividend at the earliest possible moment, the amount carried forward to reserve is frequently reduced to an unwise minimum. This is particularly true of the smaller companies. Such a policy may benefit the gambler in stock by seemingly increasing the value of his holdings, but it does not redound to the ultimate advantage of an enterprise. One has to acknowledge the right of any man to sell out at a good profit, but I doubt if the viewpoint that a mining stock should be regarded as another opportunity to play margins can do the industry any good. The industry depends for its success upon financial stability. A mine, at any one time, has a certain actual value, and no amount of manipulation in the stock market can augment or diminish that value. As a matter of fact, the application of false values has done much harm to mining, inasmuch as it has often caused unemployment. This condition has followed in consequence of the difficulty experienced in raising legitimate additional capital after a period of wild investment.

No mine can enjoy an indefinite existence. Some mines attain old age, but the majority die young. Permanency of employment at any one mine is therefore almost impossible. If the mining industry, as a whole, however, is managed wisely, money to finance a new enterprise will be forthcoming to take the place of every mine that has to close. Labor can thus be given continuous employment if individuals, and at times entire families, can and will move from one state to another, or even from one country to another. No sympathy need be wasted on the individual who lives up to his income, who does not see the small dark cloud on the horizon. On the other hand, I have seen worthy men with family obligations forced constantly to bear in mind the prospect of unemployment. The question is a serious one, not only from the standpoint of gaining a steady livelihood but also because of the effect that possible unemployment has on the morals of mankind. Moreover, possible unemployment involves a wearing and an increasing degree of self-sacrifice which is likely to lose its novelty and which certainly detracts from a man's full capacity for usefulness. This viewpoint has unfortunately had little attention and is even received with impatience. Nevertheless, it reaches down to the very roots of civilization, and must be considered by good management.

Well, how can we improve the situation? It is one thing to lay one's finger on an evil, and quite another thing to eradicate it. But closing one's eyes to a problem has never yet solved it. Our problem is either to avoid entirely the evil of unemployment or, at least, to mitigate its undesirable effects. We have seen that the giving of fictitious values to mining stock by no means promises solution of the problem. Increase of remuneration does not solve the problem in its entirety. I do not agree with a friend of mine who maintains that a mining enterprise which cannot raise sufficient capital to be able to pay good wages has no right to existence. I agree, if the basic idea in his contention is that no company has the moral right to operate should it decide to maintain dividends by a decrease in that reward to labor that local conditions have proved to be equitable. We are a long way from the millennium, and our problem will remain unsolved if we do not, for the time being, lay less emphasis on its sentimental and more on its practical phases. It seems to me that we should experiment along the lines of state insurance. The necessary funds for each industry should be met as far as possible by contributions from both employer and employee, state aid to be invoked only under exceptional circumstances. This state organization should operate a central clearing house; much unnecessary and costly drifting of labor results from the lack of such a central institution.

I do not think that any voluntary unionism on the part of the several branches of the mining profession, with a view to mutual aid, is possible at present. Those at work would wish to resign from such an organization and those unemployed would wish to join it. The advantages of co-operation can neither be taught nor learnt in a day.

New York City. PAUL T. BRUHL.

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Early Flotation Results at Anyox

To the Editor of "E.&M.J.":

Referring to Mr. Maxwell's very carefully prepared and valuable article on the Anyox concentrator of the Granby company, in your issue for April 7, 1930, it occurs to me that, as a matter of historical interest, some of your readers might like to compare the present excellent results being obtained there with some of the early results of the operation of the pilot concentrator.

The mill feed now is of course somewhat different from what it was then, particularly as to the sulphur content. However, even in 1917, long before the days of xanthate and selective flotation, fairly respectable results were obtained, as shown by the following comparison between the average operating results of the pilot concentrator for Nov. 25, 1927, and the present averages as given in Mr. Maxwell's article:

	Pilot Concentrator	Present Practice
Dry tons milled per day	65	4,800
Feed, per cent copper	1.21	1.20
Concentrate, per cent copper	9.17	16.0
Tailing, per cent copper	0.12	0.11
Ratio of concentration	8.3 to 1	14.87 to 1
Per cent copper recovery	91.4	91.63

The pilot concentrator was equipped with six Janney mechanical cells, and the only flotation reagent used was No. 80 Pensacola crude pine oil.

H. R. ROBBINS,
Oriental Consolidated Mining Company, Korea.

Montana's Chromite Reserves

To the Editor of "E.&M.J.":

Considerable interest has been created in this section of Montana by the references to Montana chromite in an article in the Feb. 8 issue of *Engineering and Mining Journal* which tend to leave the impression that these deposits are insignificant. We submit the following, taken from reports of geologists and engineers who studied the deposits.

Chromite was discovered in Montana in 1917 by J. F. Brophy, who located several claims on the Silver Run plateau about 9 miles southwest of Red Lodge, in Carbon County. Later a discovery was made in Sweetgrass County 33 miles southwest of Big Timber, just east of the Boulder River; also on Rock Creek, 42 miles southwest of Columbus. Other discoveries were made in the same general locality.

In general, the chrome apparently occurs as magmatic segregations in a huge gabbro dike 2,000 to 8,000 ft. wide and approximately 44 miles long in a southeast-northwest direction, from a point on the Boulder River 3 miles south of Contact to a point about 8 miles west of Red Lodge, where the dike turns southwest and continues for about 25 miles.

Near the center of the dike and along its long axis occur lenses of chromite ore of varying lengths and widths. Some seem to be unbroken for lengths of 5,000 or 6,000 ft. and widths vary from a few inches up to 30 ft. or more. Others show for lengths of 1,000 or 2,000 ft. and widths vary from 8 in. to 18 ft. These lenses have been proved by erosion through a vertical horizon of approximately 4,000 ft.

For example, on three mineral locations in Carbon County, 15 miles from Red Lodge, there are three lenses 30 ft. or more in width, two having a proved length of over 1,000 ft. each and one shown plainly by float for 2,000 ft. At this place the chrome ore has a vertical exposure of 1,400 ft. Samples have shown a chromic oxide content as high as 60 per cent. A mill test made on the second-class ore on 35-mesh grinding and table concentration showed 37.4 per cent Cr_2O_3, 20.9 per cent FeO, and 11.2 per cent SiO_2 in the heads, and 48 per cent Cr_2O_3, 22.8 per cent FeO, and 2.9 per cent SiO_2 in the tailing. On grinding to 65 mesh the grade of the concentrate was increased to 49.5 per cent Cr_2O_3. From what we can learn it would appear that this concentrate should be commercial in grade and usable at this time, though there appears some question as to the high iron content of the ore.

About 30 miles of the dike has been prospected, showing frequent occurrences of chromite ore, the greatest amount of work having been done on the Silver Run and Hell Roaring plateaus in Carbon County, on the Rock Creek plateau in Stillwater County, and on the East Boulder and Main Boulder rivers in Sweetgrass County.

The deposits are approachable on water grades at six points along the dike. The ores on the Silver Run plateau would require an average 9-mile haul to railroad at Red Lodge and on the Hell Roaring plateau an average 14-mile haul to the same point. In Stillwater County, the ores on the Rock Creek plateau would require a 42-mile haul to the railroad at Columbus and those on the West Stillwater a 55-mile haul to the same point. In Sweetgrass County the ores on the main Boulder would require a 33-mile haul to railroad at Big Timber and those on the East Boulder a 10-mile longer haul to the same point. D. P. BATES,

Secretary, Chamber of Commerce.

Livingston, Mont.

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Ammonia in Complex Ore Flotation

To the Editor of "E.&M.J.":

The interesting article by F. G. Bacon, in the April 24, 1930, issue of *Engineering and Mining Journal*, on the possibilities of ammonia in complex-ore flotation, regarding the inhibiting effect of ammonia on pyrite, and depression of sphalerite by zinc-ammonium sulphate, recalls numerous tests and experiments that I made prior to 1918. Referring to my U. S. Patent 1,254,173, issued Jan. 22, 1918, one claim reads as follows:

"The method of recovering the valuable elements of complex sulphide ore containing iron sulphide, which comprises the treatment of crushed ore with an ammoniacal solution and a frothing agent, thereby altering the iron sulphides to render the same substantially immune to flotation. and creating in the mixture uprising air bubbles carrying the metallic values." Also a claim in my U. S. Patent 1,334,420, issued March 23, 1920, reads as follows: "The herein described process of concentrating metals in ores consisting of treating ore in comminuted form in water containing a metal-ammonia salt and then by flotation recovering the concentrate."

It is not generally known that ammonium nitrate is also an efficient "deadener" of pyrite, especially in recleaning a bulk flotation concentrate.

Ammoniacal oil mixture or emulsion, prepared by violently agitating one volume of aqua ammonia, one volume of Cleveland Cliffs No. 2 creosote, and two volumes of water, was used in the Tomboy mill near Telluride, Colo., as the selective flotation reagent for a number of years prior to the exhaustion of the orebodies. The Tomboy Mines Company was the first licensee for the use of these patents. JOSEPH T. TERRY.

Los Angeles.

Exactitude and Rectitude in Ore Estimates

To the Editor of "E.&M.J.":

In the issue of March 8 you criticize the estimates of ore reserves made by the manager of a certain well-known gold mine, because, after first stating that owing to the nature of the deposits only approximations could be arrived at, he proceeded to give exact figures of 418,877 tons valued at $4,727,551.53. You might also have noted that the same report gives: drifting, 61,459.25 ft.; crosscutting, 12,300.9 ft.; and diamond drilling, 38,062.5 ft., all very exact figures.

My interpretation of the report is that the figures given are the exact results arrived at by compiling accumulated office data, and are the manager's unvarnished statement derived from his records. The figures are presented without trimming and are accompanied by the warning that ore reserves are difficult to figure, but to guide shareholders the manager has given them the results of his estimates. It is up to shareholders to apply their own speculative factors in rounding out the estimates that are made a part of the engineer's report.

The gentleman whose report you criticized is an engineer with 35 years of experience in estimating ore values, and he is not in the habit of trimming his estimates to round numbers. His recent analytical report on a certain base-metal property was an eye-opener to the mining public, which had been following the breezy estimates of promoters and brokers, and the sketchy deductions of less competent engineers, and paying fancy prices for base-metal shares. This last-named report punctured and deflated several hot-air balloons.

In the district where these things have occurred every crooked game known to mining has been put over, and I think you do wrong to "pan" one of the few engineers whose practice it is to hew to the line and let the chips fall where they may. P. A. ROBBINS.

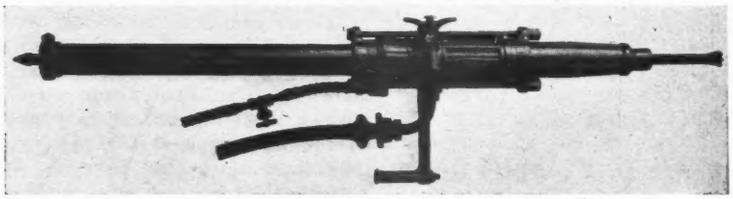
Highland Park, Ill.

[The editorial in question was not written with the idea of "panning" any individual. If written with that purpose, pains would not have been taken to maintain the anonymity of the persons involved. It was written with the idea of criticizing an absurd and widespread practice. Mr. Robbins' reference to the exactness of the other data in the report is not convincing. Diamond drilling and drifting can be measured accurately. They have been done; they are of the past. Ore reserves are of the future. At best, they can only be estimated, and mining history has proved times without number that no ore reserve estimate is accurate until the last ton of ore in the deposit has been mined.—EDITOR.]

INDUSTRIAL PROGRESS

New One-Man Stoper Drills Rapidly in Widely Varying Ground

Other New Equipment



A new automatic rotating water stoper for heavy work in hard rock

WITH the purpose of producing a better machine for drilling upper holes, an entirely new drill has been introduced by Sullivan Machinery Company, Chicago. This is the "S-2" automatic rotating water stoper, shown in the illustration. It is intended for heavy stoping work and hard-rock conditions. Outstanding among the features that have been tested in the field are: automatic rotation, ease and precision of drill-feed pressure control, combined air and water jet, automatic lubrication, and ease of handling under all conditions.

With the feed piston in, the drill is only 61¼ in. long and is readily handled by one man. It drills rapidly in all kinds of ground. Where the ground is soft, broken, or fitchery, the drill clears itself readily, making straight, true holes, according to the manufacturer. In hard, solid ground, its powerful snappy blow gives maximum cutting speed. The drill is free from vibration, runs smoothly, and is well balanced. It handles 1-in. quarter-octagon hollow steel up to 10 ft. and will drill deeper where conditions are favorable. The designers have cut down the weight where it is not required, and have furnished strength and wearing qualities at points where strain and wear occur.

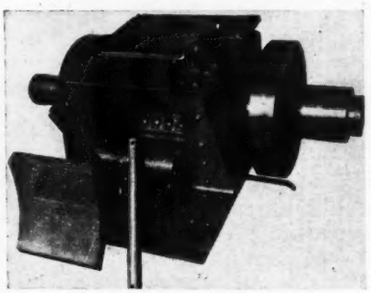
This stoper is fitted with the Sullivan cylindrical sleeve or shell valve, which permits remarkably simple and compact design with perfect control. Front and rear end cylinder cushions prevent damage to the drill. The automatic rotation mechanism is of simple, durable design and positive in action. Lubrication is supplied by a line oiler and from an oil reservoir in the hollow handle. No additional lubrication is necessary. Drill feed and throttle valve are controlled by one hand, making operation easy. The valve has a wing-type handle, which admits air to the operating valve and drilling cylinder. An auxiliary valve operated by a push button in the center of the wings controls the air to and from the feed piston.

An adjustable valve controls the flow of water to the water tube. From this valve the water goes into the back head and directly to the tube, which discharges well into the mouth of the steel. A jet of live air surrounds this tube, sealing it against leakage and providing pressure that assures delivery of the water to the drill point. Water leakage at the chuck is prevented by its inclosed dust-proof and water-tight design, which also protects the working parts from drill cuttings and other abrasives. The exhaust air is directed away from the operator.

All parts of the stoper are made from either drop-forged billets of alloy steel or from tool-steel bars, specially hardened, and ground and lapped to fit. All parts are interchangeable. Hollow-hexagon shankless steel, ⅞ or 1 in. in size, may also be used, but requires the use of a special chuck bushing.

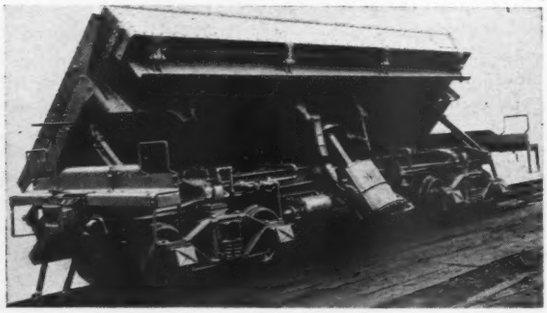
Air-dump Car of Drop-door Type for 36-in. Gage

Success of the standard-gage air-dump cars of the drop-door type has led to the development of a similar car for 36-in. gage. A car of this type and gage, and of 10-cu.yd. capacity, has been designed by the Western Wheeled Scraper Company, Aurora, Ill.



This stone crusher is of the hammer-mill type. See opposite page.

It is intended for all kinds of stripping and mining work where local conditions make narrow-gage equipment desirable. It is of low loading height and without locking mechanism of any kind. The cross sills rest directly on the underframe draft sills, supported on side pivots. The bed cannot be dumped until air has been let into the cylinders, thus eliminating the possibility of accidental dumping through carelessness. The dumping operation is effected quickly with relatively small air consumption by means of single-stroke cylinders, one on each side of the bed. The down-turning door acts as a chute, throwing the load to a greater distance from the track than is possible with the lift-door type of cars, thus eliminat-

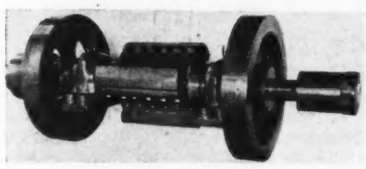


This air-dump drop-door car is of 10 cu.yd. capacity and for 36-in. gage track

ing much spreading. Wherever practicable, structural shapes, flat plates, and bars are used in construction, instead of flanged plates, to simplify repairs and reduce maintenance costs to a minimum. Weight is approximately 30,000 lb.

Stone Crushing on a New Principle

A new crusher, recently developed by the Western Wheeled Scraper Company, Aurora, Ill., is said to utilize an entirely new principle as applied to stone crushing. In it the principle of the hammermill is adapted, the hammers, however, being rigid instead of swinging. The frame is built of structural-steel shapes and plates, and within it a 20-in. rotor revolves at 1,000 r.p.m., carrying with it three steel hammers which are rigidly fastened to it. These hammers are each 20 in. long and strike 50 blows per second against the rock as it falls through the opening, with the result that the rock is broken instead of crushed. That part of the feed which is insufficiently broken is forced



Three steel hammers are rigidly attached to rotor

between the revolving hammers and a fixed die which is barely cleared by the hammers as they whirl around. After this crushing, the oversize is returned for regrinding.

The rotor is supported by two oversize self-aligning roller bearings, which are sealed in dust-proof housings and require oiling twice a week. Wear on hammers and die is taken up by shims which can be inserted without loosening a bolt. The crusher weighs 6,000 lb., has a 9x20-in. opening, and will produce from 20 to 30 cu.yd. of 1-in. stone per hour, with smaller power consumption than other crushers of greater size and less capacity.

Balancing Screen Vibration Proved Effective

The balanced vibrating screen made by the Smith Engineering Works, Milwaukee, Wis., has been described in an earlier issue. In it the two decks move in opposite directions, this opposed eccentric action automatically balancing the unit, so that little vibration is transmitted. This corrects the tendency of the unit to shake itself to pieces. The effectiveness of the scheme has been strikingly demonstrated recently in the field, according to the manufacturer. Without consulting the latter, a customer removed the screen trays from the bottom deck, thus virtually converting the unit to a single-deck vibrator. Before this change the machine was running smoothly, but as soon as the lower deck was removed the vibration became very pronounced. Then he bolted some angles to the bottom deck, restoring the balanced condition, whereupon the vibration again disappeared.

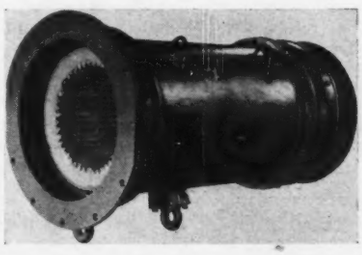
This sheave has been designed especially for slushing service. See text below, at right.

For Lifting Magnets

A new automatic lifting-magnet controller with an automatic drop arrangement has been developed by Cutler-Hammer, Milwaukee, Wis. Its automatic drop feature relieves the operator of an extra operation of the master switch each time the magnet is unloaded, giving him more time to operate the engine and brake levers and saving considerable time in loading and unloading. The new controller is fully inclosed to protect the operator against shock and flying particles, and the controller against damage. The mechanism is mounted on an asbestos lumber panel which is moisture-proof and withstands heavy shocks.

New Gas Burners

For use in kilns, driers, boilers, furnaces, ovens and similar installations, the Denver Fire Clay Company, Denver, Colo., has developed a so-called Type A-DFC atmospheric gas burner. This burner is intended to solve the problems met in burning artificial or natural gas. It consists of four parts: a nozzle, a throat, a spud, and an air shutter. Throat and nozzle are made of highest-grade refractories, offering the same heat-resistance as the walls of the apparatus itself and assuring long life. The nozzle is provided with longitudinal edges or riflings, to increase the efficiency of the burner and to accelerate combustion. When the burner is fired, these fins become incandescent, acting as a combustion accelerator. This prevents the flame from blowing out even when under a strong draft. Another feature is in the throat, which has the shape and performance of a Venturi tube. Because of this arrangement, the gas upon leaving the spud sets up a powerful vacuum, assuring the injection of sufficient air to the shutters at all gas pressures. As natural gas requires 10 cu.ft. of air for each cubic foot of gas consumed, which is slightly more than twice the amount of air required by artificial gas, this type of throat obviously makes greater efficiency possible. The burner also has an improved air shutter for controlling the exact amount of air supplied. This consists of a circular disk installed on a spud extension, which can be adjusted to any desired volume.



Atmospheric gas burner of 20,000 cu.ft. hourly capacity

Another burner, known as the "DFC," and utilizing gas as fuel, is built upon the same principle as the Type A burner just described, but is intended for use only with boilers. It has been designed specifically for such work and is said to assure definite fuel economy, reduced labor, and lower maintenance expense.

A New Sheave for Slushing

Success of underground scraper loading depends on the freedom from delay with which the work is attended. Earlier designs of sheaves available on the market have frequently failed to meet the severe service, causing delays by jamming or splintering of the wire rope, wearing out the bearings, and by the binding of the pulley against the side plates. Engineers of the Sullivan Machinery Company, Chicago, have designed a new sheave or tail block for use in connection with this kind of work. It is built in 8, 10, and 12 in. diameters, and is of unusually heavy and sturdy construction. The sheave itself is of manganese steel with side plates of electric steel castings. In this device the hook is of drop-forged alloy steel and may be replaced by a swivel eyebolt if desired. The Hyatt roller bearing supporting the sheave revolves on a hardened steel shaft of large diameter, which is hollow and serves as a reservoir for lubricant. The sheave is recessed into the side of the plates, thus preventing the possibility of jamming as well as undue wear on the rope. Snatch block construction has been employed and the block may be readily opened by removing a pin. Pressure fittings are provided.

Automatic Switching for Motor Generators

New simplified automatic switching equipment, available for the control of standard-size motor generators for mining service, has been announced by Westinghouse. This is for controlling 100, 150, 200, and 300 kw., 2,300 volt, a.c., three phase, 25 or 60 cycles, 250-275 volt, or 600 volt d.c. motor-generator sets.

Automatic switching equipment pro-

vides for starting and stopping the unit by means of a remotely mounted push button, or a control switch mounted on the switchboard. The motor-generator is connected to the auto transformer for reduced voltage starting, after the starting impulse has been given by the closing of the push button, or the control switch, and relays indicate correct starting conditions. When the unit reaches synchronous speed, the generator voltage is built up, and the synchronous motor field is excited, the motor is connected to the full line voltage. If the d.c. line conditions are normal, as indicated by the automatic reclosing equipment, the generator is automatically connected to the line.

A New Mine Fan

One of the accompanying cuts shows a high-speed mine ventilating fan, recently introduced by American Blower Corporation, Detroit, Mich. This fan is of aluminum alloy construction and is not only light and easily portable but resists mine corrosion. It has been designed to obtain the maximum possible air delivery from the 5-hp. motor under actual operating conditions.

The Heaviest Belt Conveyor

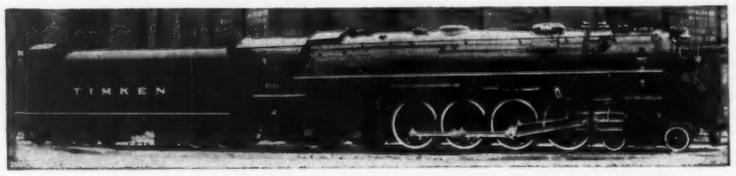
What is said to be the heaviest and thickest conveyor belt that has ever been used has recently been installed in the new screening plant of the Michigan Limestone & Chemical Company. It is 54 in. wide and of stepped-ply construction, having sixteen plys at the side and fourteen at the center. The top cover is $\frac{13}{32}$ in. thick, and the duck used is of 42-oz. weight. Total thickness of the belt is $1\frac{3}{4}$ in.

The conveyor is 700 ft. long, center to center, the vertical lift being 147 ft. It is handling 1,950 tons per hour discharge from a 60-in. primary crusher. The maximum size of pieces is 15 in.

The conveyor was shipped in three rolls, each of huge dimensions and weighing 21,000 lb., and was spliced in the field in a vulcanizing press to make the belt endless. In spite of its thickness, the belt troughed perfectly without a load when installed. For this conveyor a special tandem drive was designed, each 84-in. pulley being driven independently by a 250-hp. motor. Special 54-in. Timken bearing idlers were designed for this installation by the engineers of the Robbins Conveying Belt Company, New York, the manufacturer.

A light, portable corrosion-resisting mine fan, by reason of its aluminum construction

Timkenizing a Locomotive for Test Purposes



Equipped with anti-friction bearings throughout, this 711,500-lb. locomotive is to be subjected to a two-year test on various roads in both freight and passenger service

To demonstrate the possibilities of anti-friction bearings as applied to the axle journals of steam locomotives, the engineers of the Timken Roller Bearing Company resorted to the extraordinary means of building a locomotive equiped throughout with Timken bearings and suitable for service on both freight and passenger runs. This locomotive was intended to serve as a means of obtaining complete and accurate data on every phase of bearing performance under every variety of operating conditions. The plan further calls for lending the locomotive to different railroads for varying periods, to be used in their regular service. During its stay on each road the performance of the engine and of the bearings is to be carefully observed and recorded. It is estimated that two years will be required to complete the tests.

In pursuance of the plan, the American Locomotive Company was commissioned to build a locomotive of the 4-8-4 type, according to specifications furnished by the Timken company's engineers. This locomotive was completed and had its preliminary trials a short time ago, and has been turned over to the Pensylvania Railroad for its first test. The service for which it is intended and the fact that it is equipped with tapered roller bearings necessitated several novel features in design and construction, so that it represents an entirely new chapter in locomotive development.

The locomotive is shown in one of the accompanying illustrations. Essentially it has a total length with tender of 102 ft. and a total weight of 711,500 lb., the engine weight being 417,500 lb. It has a maximum speed of 85 miles per hour, and operates on two alternative steam pressures, 250 and 235 lb. respectively. The weight on the drivers is adjustable, so that there are two tractive effort ratings. Maximum starting effort at 250-lb. steam pressure is 76,500 lb. and at 235 lb. 71,900 lb. This alternative rating is made necessary by the variations in the weight limitations in force on different roads.

This engine is the first to be so completely anti-frictionized. Tapered-roller bearings are used on the main drivers, the engine trucks, trailer trucks and tender trucks. They are also used on the crankshaft and the idler gear of the Franklin booster. Since each application presented individual problems and operating requirements, a different method of mounting the bearings was used in each case.

Another feature of the locomotive is the novel use of alloy steel parts. These play an important part in meeting the specifications as to speed. The permissible top speed was obtained in part by the use of heat-treated one-piece pistons, heat-treated hollow piston rods, heat-treated nickel-vanadium steel crossheads, and side rods of normalized $2\frac{1}{4}$ per cent nickel steel. The result was that the weight of the reciprocating parts has been reduced 460 lb. per side. In the case of the crosshead guides, not only was the weight reduced in this manner, but the wearing quality was greatly improved. On the whole, the locomotive is expected to effect revolutionary changes in railroad practice. According to the Timken engineers, it combines the characteristics as to speed of the passenger locomotive with the power and capacity of the modern high-speed freight locomotive. Its performance from a practical and an economic standpoint should show an enormous improvement.

Bulletins

Lubricants—Merco Nordstrom Valve Company, 343 Sansome St., San Francisco, Calif. Manual on lubricants.

Screens—Orville Simpson Company, Cincinnati, Ohio. Catalog No. 80. Rotex screens.

Roller Bearings—Roller Bearing Company of America, Trenton, N. J. Catalog No. 40. Heliflex bearings.

Personal Notes

JAMES R. HOBBINS

James R. Hobbins was elected a director of Anaconda Copper for three years, at the annual stockholders' meeting at Anaconda, on May 21. He succeeds the late Nicholas F. Brady, whose term would have expired at this time. Mr. Hobbins became connected with the Montana Power Company in 1912, and was subsequently made manager of the Great Falls district. In 1922 he was appointed assistant to the president of the company, with headquarters in Butte, and a year later was made vice-president in charge of all Montana operations. He is 47 years old, and a graduate of the engineering school of the University of Wisconsin.

Edwin Mills is in New York, at the Harvard Club.

Arthur Zentner, of San Francisco, is in New York.

Louis A. Ware is expected in New York from Los Angeles.

Herbert S. Gieser, metallurgist, formerly of El Molino, Sonora, Mexico, is now in San Francisco.

L. W. Strauss has returned to New York from a recent professional trip to Virginia and North Carolina.

James R. Finlay and **Arthur Notman** announce that they have removed their offices to 40 Wall St., New York.

Chester Beatty, chairman of the board of directors of Rhodesian Selection Trust, is expected in New York from London.

J. F. Kapnek, director of several South African mining companies, has returned to South Africa after a visit to the United States and England.

Dr. **C. Camsell,** deputy Minister of Mines, Ottawa, was elected president of the Royal Society of Canada at the recent annual meeting in Montreal.

H. W. Gartrell, head of the Mining School of the University of Adelaide, left Australia early in May for a tour of American and Canadian mining fields.

Philip D. Wilson, of the staff of American Metal, has returned to the New York office of the company, from a trip to South Africa and a subsequent visit to several mines in Europe.

F. W. Snow, J. F. McLanahan, and **Lawrence Geraux,** all of the staff of **Archer E. Wheeler,** arrived recently in Moscow, headquarters of the Wheeler staff in Russia.

Arthur V. Corry, mining engineer, of Butte, was elected president of the Montana Society of Engineers, at the meeting on May 12 at the Butte Chamber of Commerce.

J. B. Tyrrell, managing director of Kirkland Lake Gold, was awarded the honorary degree of Doctor of Laws, at the commencement exercises of the University of Toronto, on June 5.

Roy F. Fuhrman, of Rochester, N. Y., who graduated from the New Mexico State School of Mines this spring, has accepted a position with Continental Diamond Drilling, of Quebec and Los Angeles.

A. E. Carlton has resigned as president of Golden Cycle, but remains a member of the board of directors. He is succeeded in the presidency by **L. G. Carlton,** who was vice-president and general manager.

Kirby Thomas was one of the valuation experts for the estate owning Mammoth Cave, Kentucky, in the recent condemnation proceedings brought by the State of Kentucky to secure this natural wonder for a national park.

H. I. Altshuler has been appointed general superintendent of mines for the Cia. de Real del Monte y Pachuca, with headquarters at Pachuca, Hidalgo, Mexico. Mr. Altshuler was formerly consulting engineer to the company.

James D. Sisler has resigned as Associate State Geologist of Pennsylvania, to accept the office of West Virginia State Geologist, to which he was recently elected. He will assume his new duties at Morgantown, W. Va., on July 1.

Philip R. Bradley recently left San Francisco on an annual inspection of properties for which he is consulting engineer. He will visit Yellow Pine, in Idaho; Alaska Juneau, at Juneau, Alaska; and Treadwell Yukon, at Mayo, Yukon Territory.

F. W. Maclennan, general manager of Miami Copper, will give an address on the world copper situation and his trip to Africa at the June 17 meeting of the Chamber of Commerce of Globe, Ariz. He is expected to return to Miami early in June.

Frank M. Smith has been elected president of the Northwest Lead Company, affiliated with Bunker Hill & Sullivan. He is smelter director for Bunker Hill and metallurgical engineer for Treadwell Yukon. He is past vice-president of the A.I.M.E. and also past president of the Northwest Mining Association.

Willard E. Hales has resigned as superintendent of the Tybo mine of Treadwell Yukon, at Tybo, Nev. He had been in charge of operations since their start. Mr. Hales is succeeded as superintendent by **George I. Barnett,** of the engineering staff of the company. Mr. Barnett was formerly on the engineering staff of West End Consolidated, at Tonopah, Nev.

H. E. Aspoes, K. C. Cartwright, George Clemens, Mr. and Mrs. **F. E. Gray, I. S. James, A. L. Foss,** Mr. and Mrs. **John Lea, R. C. Robin, K. A. Rogers,** and **F. W. Uhler** sailed from New York for Moscow on June 3, on the "Berengaria." This group of engineers is one of those sent by Oglebay, Norton & Company. They will be connected with the Stal (The Iron Mining and Furnace Trust of the U.S.S.R.).

OBITUARY

Walter S. McKee, president of the Kensington Steel Company, of Chicago, died in Chicago on May 19.

Lew Davis, of Ophir, Utah, died on May 20, at Agua Caliente, N. M. He was interested in the development of several properties in Utah and Montana.

A. V. Krassow, mining engineer, died suddenly in Glendale, Calif., on May 24. He was 52 years of age and had been connected for several years with Cananea Copper, at Cananea, Mexico.

James T. Kescel, formerly mill superintendent for the old Daly Judge Mining Company, at Park City, Utah, died at his home in Monroe, N. Y., on May 12. Mr. Kescel was 80 years of age.

Reginald A. Black, mining engineer and inventor of a process for the extraction of vanadium from its ores, died in Tucson, Ariz., on May 20. He was a native of Australia, and a graduate of the University of Sydney. He is survived by his widow and two children, who live in Sydney.

W. A. Quince, who resigned several months ago as manager of Sub Nigel, lost his life in a recent accident at the Ariston mine, in the Gold Coast Colony. Mr. Quince had just returned to Africa from London, in connection with the development of the district between Heidelberg and the Vaal River.

Joseph H. Vivian, a resident of Butte for the last 43 years, died on May 15, after a brief illness. He was connected with the Boston & Montana Mining Company, which was absorbed by the Amalgamated Copper Mining Company, and is now a part of the Anaconda Copper. George Vivian, his son, is a member of the geological department of Anaconda. Mr. Vivian was 69 years old.

Dr. **Kuno B. Heberlein** died suddenly in London on June 1. He was born in Switzerland in 1874, and was a graduate of the University of Basle, with the degree of Ph.D. He was a citizen of the United States, and spent a large part of his life in this country. He was connected with the development of the Huntington-Heberlein pot-roasting process and the Harris lead refining process, which he also introduced in this country. Until 1921 Dr. Heberlein was vice-president of American Metal and president and general manager of Peñoles Mining, Mexican subsidiary of American Metal. He was also at one time president of the Metallurgical & Chemical Corporation, and had extensive mining interests in Europe, Australia, and South America. During the last two years Dr. Heberlein lived in London.

NEWS OF THE INDUSTRY

Geological Survey Obtains Funds for More Research

Appropriation of a new $100,000 item for pure research by the U. S. Geological Survey will facilitate several important lines of mining study, according to plans set by Bureau officials. The increase of $50,000 in the regular federal budget of the geologic branch for the next fiscal year will be an added help, as the regular surveys often become research problems in many essentials. Studies of the nature and occurrence of orebodies will be a part of the program.

Among the problems under consideration are: the enrichment of sulphide ores—possibility of developing orebodies that have been worked out; relation of ore deposits to intrusive volcanic centers; processes of rock weathering and their relation to the accumulation of manganese, aluminum, and iron ores; origin and nature of ceramic clays; ore- and vein-forming solutions; part played by colloids in ore deposition; occurrence of helium in the earth's crust; and the origin of Death Valley. Studies in the petroleum field will include the systematic classification of microscopic fossils of oil-field value and general studies relating to the origin of petroleum and its formation in pools. Several new junior geologists will be employed during this summer's field season to permit releasing trained men for the special studies.

■

Officials Object to Suspension of Assessment Work on Claims

Senator Smoot's bill to suspend annual assessment work on mining claims has been unfavorably reported by the Department of the Interior, according to a statement read in the Senate on June 2 by Senator Oddie, of Nevada, chairman of the Committee on Mines and Mining. The proposed measure would have relieved the holders of mining claims on the public domain from the requirement that $100 worth of work be put into the claim each year. This would have applied through 1929 and 1930, being retroactive for the former year. The purpose was to relieve small holders from a burden which might become heavy under present conditions of depression.

Objections were outlined in a letter from C. C. Moore, commissioner of the General Land Office, indorsed by Secretary Wilbur. The present law, Mr. Moore pointed out, tends to discourage speculative locations and non-productive holdings by non-residents while it encourages extraction of the ores. Local labor would be hard hit by the proposal, it was declared.

■

Palisades Plant Resumes

Milling has been resumed by Banner Development, at its Palisades silver-gold property, near Calistoga, Calif., after a shutdown during which improvements were made, bringing mill capacity up to 120 tons per day. The plant formerly handled 60 tons.

Tri-State Output About 75 Per Cent of Production Rate a Year Ago

Voluntary Curtailment Disappears as Low-Cost Mines Meet With Success in Effecting Economies—Wages Will Be Cut as Price of Concentrate Drops to $31

PRODUCTION of zinc concentrate from the Tri-State district is about 25 per cent less than a year ago, as a result of the slump in metal prices. About 9,500 tons of zinc concentrate is being produced weekly, compared with about 13,000 tons last year. The average grade of concentrate is 58 per cent zinc. The effect of the drop in the price of zinc concentrate from $42.50 to $31 a ton has been to eliminate the high-cost Tri-State producers. Voluntary curtailment is no longer an important factor, as it was a year ago. The low-cost mines continue to operate and are attempting to cut costs even further. In this attempt, wages are being cut. Increased efficiency is visible in Tri-State operations.

A year ago about 120 mills were producing an average of 107 tons each of zinc concentrates weekly. At present about 85 mills are operating, and the average weekly production is 117 tons per mill. Some of the increased production per mill is due to the fact that a majority of the 35 mills now idle that were operating a year ago were high-cost, low-grade mines that could neither reduce costs nor increase recovery to a point where an operating profit was possible. This condition seems to be the only curtailment program in evidence—when a mine cannot make a profit it ceases to be operated. Few mines capable of making a profit on current prices are idle at present. These companies prefer to hold valuable ore reserves for an upturn in the market.

Operators' efforts to reduce costs are portrayed in the monthly cost data compiled by the Tri-State Zinc and Lead Ore Producers' Association. In March, 1930, the average cost of producing a ton of concentrates (zinc and lead combined) was $35.70 a ton, the lowest since the organization began compiling costs data in 1924. This compares with $38.54 in March, 1929, which was below the 1929 average. Producers realized an average of $43.50 a ton for concentrates (zinc and lead combined) in March, with zinc at $37 and lead $66.50, or, in other words, made a net profit of $7.80 a ton on the 58,000 tons of concentrates (zinc and lead) sold during the month.

Lower costs can be attributed to the increased recovery of lead and zinc, closing of some of the low-grade properties, and extraction of the higher-grade ore. Average metal content recovered increased from 5.65 per cent in December, 1929, to 6.21 in March, 1930.

The decline in the price of zinc concentrate, from $35 on April 26 to $31 on May 24, has brought additional pressure for lower costs, which is being realized by a rather general cut in wages. Though ordinarily regulated by each $5 change in price, they have not been cut since zinc concentrate was selling for $44 a ton. The cut will amount to 25c. a shift for day men and 1c. a "can" for shovelers. No set basis rate of pay prevails in the mines. Machine men receive from $4.25 to $5 a shift, depending on the nature of the mine, its location, and other duties involved.

Lower price, bringing the necessity for lower cost, is slowly crystallizing miners' minds toward the fact that a change in operating conditions is inevitable. Consolidations, with possibilities of continuous operations, instead of the ten-hour shift, are expected to enable the district to lower costs considerably and make it possible to profit on present or even lower prices. The advantage of the proposed consolidation of the mines of Eagle-Picher Mining & Smelting, subsidiary of Eagle-Picher Lead, with those of Consolidated Lead & Zinc, another subsidiary, is based on these premises.

Mines of the district are employing about 5,200 men at present, or about 1,000 less than a year ago, and 3,000 less than several years ago. Unemployment has been an acute factor in the district for the last year, but has eased perceptibly in the last few weeks, with the opening of the berry fields.

Recent floods caused considerable damage to mines and reduced output about 2,000 tons. All mines operating before the floods, with the exception of the Black Eagle, are again able to operate. The Black Eagle probably will be unable to operate for at least another month. Other mines are flooded, but these probably could not be worked on present prices.

The west Baxter Springs sheet-ground district, of which much was heard a year ago, is practically inactive. St. Louis Mining & Smelting is operating its Ballard mill, one of the largest all-steel structures in the field, but is not selling its production. Commerce Mining & Royalty has closed its Paxson mill; Interstate Zinc & Lead has closed the Hartley; and Velie Mines, the Leopard. Commerce Mining & Royalty is completing the Jay Bird mill, in the western Oklahoma section of the field, and probably will begin operating soon. This plant will treat ore from several allotments of restricted Indian lands and undoubtedly will be operated on a continuous basis. This operation should give this company, the field's largest producer and the holder of huge reserves, some idea as to the cost-cutting possibilities of continuous operations.

Inco Curtailing at Creighton as Frood Output Increases

By July 1, the Frood mine of International Nickel will be producing at the rate of 100,000 tons of ore monthly, and soon thereafter production will be raised to 125,000 tons monthly. This output will meet the forecast made in the last annual report of the completion of the Frood equipment program by midsummer. As a result of the increased production of high-grade copper-nickel ore at the Frood, production will have to be curtailed at the Creighton mine, which up to the present has borne the brunt of furnishing ore for the company's old smelter at Copper Cliff. Starting June 1, the rate of production at Creighton was reduced from 100,000 tons to 50,000 tons of ore monthly. International Nickel has no immediate plans for resuming production from the Levack mine, where surface buildings destroyed by the fire last December have been replaced.

Next week will see the first shipment of blister copper arriving from Port Colborne to be refined in the new plant of the Ontario Refining Company at Copper Cliff. Up to the present, copper-nickel matte has been shipped to Port Colborne for separation, the nickel then being refined there and the copper being sent to Carteret, N. J., for treatment in American Metal's refinery. Because of the construction of the new 120,000-ton copper refinery at Copper Cliff, however, the separating plant will be moved there from Port Colborne.

Production at the rate of 125,000 tons of ore monthly from the Frood mine, where the average grade of ore has been officially stated as 2.39 per cent nickel and 3.62 per cent copper, indicates a monthly output of about 2,500 tons of nickel and 4,000 tons of copper monthly from this mine alone. In 1929, International Nickel produced about 55,000 tons of nickel and 43,500 tons of copper.

■

Survey Announces Program for Coming Season in Alaska

The U. S. Department of the Interior announces plans for the surveys that will be conducted in Alaska during the coming season by field parties of the Geological Survey, in continuance of the investigation of Alaska's mineral resources. The projects include exploratory and reconnaissance geologic and topographic surveys in several parts of the Territory and more detailed examinations of certain tracts and mineral commodities.

In southeastern Alaska mineral investigations will be undertaken in the newly discovered lode areas in the vicinity of the Taku River, east of Juneau. This work will be assigned to B. D. Stewart, supervising mining engineer, whose headquarters are at Juneau. If time permits, Mr. Stewart will also carry on general studies of mineralization in the Juneau and Chichagof regions.

In south-central Alaska two geologic parties—one in charge of F. H. Moffit and one in charge of S. R. Capps—will study mineral deposits in the vicinity of the Alaska Railroad, especially those that appear to hold promise of being productive of tonnage for the road. Much of the time of the Moffit party will be spent in the Kantishna region, where lodes of silver, lead, gold, and other metals have long been known, but some time will be devoted to special geologic problems of significance to the railroad. The principal work of the Capps party will consist of surveys in the vicinity of Broad Pass and at the head of the Chulitna River, where mineralized areas have long been known, though not heretofore fully studied.

In southwestern Alaska a topographic exploratory and reconnaissance party in charge of Gerald FitzGerald will conduct surveys in the large unmapped tract north of Nushagak and Dillingham. Little is known regarding the potential mineral resources of this tract, but near-by regions are known to be mineralized. If the results of this exploratory survey afford promising indications, it is probable that the Geological Survey will undertake extensive topographic and geologic investigations in the tract in the near future.

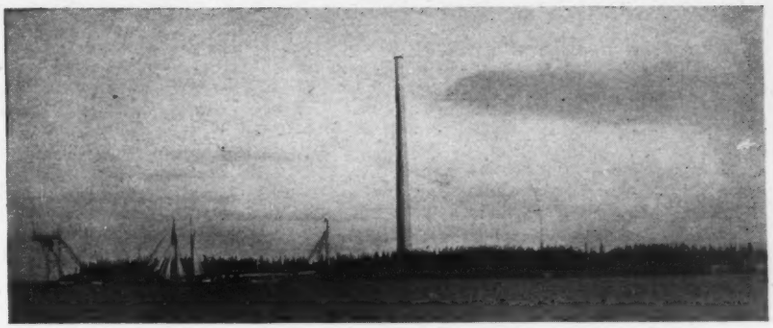
In the Yukon region a geologic reconnaissance party in charge of J. B. Mertie, Jr., will conduct surveys in the unmapped tract lying north of the Yukon and south of the Porcupine River, adjacent to the international boundary. This is a large tract, and only a small part of it can be visited during the coming field season, so that Mr. Mertie's main object will be to procure general information as a basis for plans for more comprehensive surveys in succeeding years. This region is not known to be mineralized, but there are indications that mineral deposits may occur there, and as it lies so close to the Yukon, which forms an easy avenue of transportation, a reconnaissance to determine its real character seems well justified. Previous surveys near this region indicate that it probably contains one of the most complete Paleozoic sections that can be found anywhere in Alaska and one that has undergone only a relatively slight amount of metamorphism, so that this project holds good promise of yielding definite geologic information that will be pertinent to the study of the geology of the entire central part of Alaska.

The chief Alaskan geologist will carry on general studies of recent mineral developments in certain of the mining districts throughout the Territory, with the aim of gathering facts essential to preparing the annual statistical canvass and maintaining a general administrative oversight of the Geological Survey's work in Alaska.

■

Glacier Mill in Operation

After enlarging and remodeling its concentrator, Glacier Silver-Lead, at Libby, Mont., has started production again. The plant, which now has a capacity of 350 tons of ore daily, is operating on two shifts. Only two men are needed per shift. L. E. Neale is superintendent of the plant. At the mine, stopes have been prepared on the west vein at the main haulage level.



Europe's tallest stack—at the new Bolliden copper smelter in Sweden

Urquhart Estimates Reveal Size of New Guinea Gold Field

On the upper plateau of the holdings of New Guinea Goldfields, in New Guinea, workings have been driven for a distance of 7,000 ft. along the strike of the vein to a depth of 300 ft., according to Leslie Urquhart, chairman of the company. Assuming—and the company expects the assumption to be correct—that the ore continues of the same grade in the gaps between the several workings, Mr. Urquhart estimates that the orebody contains 182,000 tons of ore for every 100 ft. of depth. The ore now averages more than £4, or about 1 oz. of gold, per ton. A study of the geology has indicated that the ore will continue for a depth of at least 3,000 ft., as the plateau is at that elevation above the gold-bearing Wau holdings.

In addition to this orebody, the company has several indications of parallel lodes on the plateau and has proved several orebodies in the Wau ground. One of these, 400 ft. long and 138 ft. wide, has already been proved to contain 100,000 tons of ore, averaging £5 per ton, to a depth of 25 ft. Erection of a first mill unit at the property to afford large-scale testing facilities is now being considered by the company.

■

Apply Geophysics to Study of Earth Movements

Seismic methods will be used to study earth movements by the U. S. Bureau of Mines, under a co-operative arrangement with several railroad owners and quarry operators, during the coming summer and fall. These interests are anxious to know more about earth movement resulting from blasting and from the movement of trains. The Bureau of Mines has done a large amount of work of this character in connection with its geophysical studies and is in a position to undertake the proposed experiments without large expenditures.

■

Little Pittsburgh Mill Ready

Construction of the new 200-ton flotation plant on the Little Pittsburgh property of Pine Creek Lead-Zinc, in the Coeur d'Alene district of Idaho, has been completed, and the plant is now ready to produce. Because of the low metal prices now prevailing, operations will not be started at present. In addition to the mill, the company has built a boarding house for fifty men and has developed the orebody above No. 3 tunnel level. H. J. Rossi and M. L. Savage organized the Pine Creek company.

Inspiration Only Large Mine to Curtail in Globe Area

Although Globe-Miami, in Arizona, is known as one of the higher-cost copper districts in the United States, Inspiration Consolidated is the only one of the large producers to make a cut in its output as a result of the drop in the price of the metal. Inspiration closed its concentrator on June 1, and is now centering production at its leaching plant. Old Dominion and Miami will both maintain production at present levels, the latter producing 17,500 tons of ore daily and the former about 1,600 tons. Van Dyke Copper, which has been developing its property, is changing back to a one-shift basis and will ship only 1,000 tons of carbonate ore monthly, compared with April production of 1,600 tons. Because of the smaller concentrate output, the International smelter will operate only one furnace.

Since the Inspiration leaching plant was started in 1926, the 18,000-ton concentrator has not been run at capacity, as about 9,000 tons daily has been diverted to the leaching plant. In 1929, only seven or eight of the twenty sections in the concentrator were operated, and production of copper from concentrate was only 42,953,405 lb., compared with 64,349,914 lb. from the leaching plant. More recently, only two or three sections of the concentrator have been operated.

Inspiration put its new plant for treatment of primary slimes from leaching ores into operation late in April. Tests had shown that the presence of considerable minus-200-mesh material in the leaching charges adversely affected extraction. By wet classification, about an 80 per cent separation of the minus-200-mesh material has been effected. In 1929, as a result of this change, leaching extraction was about 89.1 per cent, as compared with 80.4 per cent in 1928. The slimes, which had been stored, are now being treated in the new plant at the rate of 600 tons daily.

Old Dominion has let a contract to the El Paso Foundry & Machine Company for the erection of a 140-ft. steel headframe over its A shaft. This will be twice the height of the present timbered headframe. A 1,500-ton surge bin will be built on the headframe and then the entire A shaft will be lined with concrete. Old Dominion does not intend to reduce operations, although the new work around the A shaft will probably cause a few two- or three-day shutdowns.

Magma, in the neighboring Superior district, has not curtailed recently, but will probably try to give most of its employees their vacations in June. Magma gives most of its miners a chance to recuperate in this way, so production will probably be low for the month. In June, the company plans to do a large amount of construction work around the shafts that would ordinarily interfere with regular production.

■

Work at Christmas Copper Centers on New Shaft

Sinking of the new shaft that will permit more extensive development and production from the property at depth is the most important work now being done at the Christmas Copper property, near Hayden, Ariz. The shaft, known as the No. 4, is now below 350 ft. The large double-drum electric hoist and steel headframe formerly used on the Iron Cap shaft, near Globe, have been moved to Christmas and erected on No. 4 shaft.

Stations have been cut at the 650 and 800 levels of No. 3 shaft and crosscuts are now being driven to the site of No. 4 shaft. Reserves of developed ore at the property are now at the highest point since it was acquired. With the new hoisting and development facilities, the company hopes to be able to continue operations on the present scale of about 450 tons of ore daily, in spite of the lower price of copper.

Wage Cuts at Copper Camps

Beginning June 1, wage cuts were made at copper camps throughout the West, in keeping with the sliding scale arrangement that exists at most of them. In Arizona the cut was 10 per cent and in Montana 50c. per shift. Quincy Mining, in Michigan, has cut wages 10 per cent. Copper Range, Calumet & Hecla, Mohawk, and Seneca will cut wages 10 per cent on July 1. When these changes are completed, prevailing wages will be the same as those obtaining prior to the fall of 1928.

■ ■ ■

First Mexican Mining Congress Forms Committee on Legislative Reform

MEXICO'S first mining congress closed its sessions in Mexico City on May 17 after an enthusiastic and harmonious gathering. A total of 97 delegates attended, representing practically all the important mining and metallurgical interests in Mexico and several independent operators as well. At the closing of the congress, a permanent committee on legislative reform was organized to keep in touch with government officials. This committee will have a board of control of three men, the committee itself having fifteen members. G. P. Garcia, president of the National Mining Chamber, is chairman of the board of control, and the other members are E. C. Creel, formerly Mexican Minister of Foreign Affairs, and Faustino Roel, formerly Under-Secretary of Communications. Before adjourning, the congress unanimously voted to recommend the establishment of a National Mining Institute in Mexico City and to call an international congress of representatives of the principal silver-producing countries of the world to discuss the international aspects of the white-metal situation, as well as local economic conditions. A vote was passed recommending research for increasing the use of silver in the fine arts and crafts as an outlet for surplus production.

A carefully worded communication was addressed to President Ortiz Rubio suggesting the appointment of practical mining men on commissions to revise the present mining code and urging prompt action in the matter. A plea was made that certain sections of Article 123 (covering labor legislation) in the constitution be repealed as preliminary to formulating legislation that would be fair to labor and capital and result in harmonious team work. Stress was laid on the advisability of early action in this respect, in view of the necessity of some definite legislation permitting immediate consideration of applications for shutdowns or readjustments in properties where ores had been exhausted or other conditions made continuation of operations impossible.

Recommendations were adopted urging the abolition of the present system of superfluous mine inspectors, which acts as a deterrent for opening up new properties; a reduction of the present taxes on mine holdings to 6 pesos per annum per pertenencia; and abolition of the sliding scale which prevents large companies from carrying on exploration work as formerly. One of the principal recommendations to the Treasury Department is that the present production tax be modified, exempting silver from taxation when the price is 45c. an ounce or less on the New York market; paying one-third of the present tariff on silver between 45c. and 50c. an ounce; and two-thirds the present rate on silver up to 60c. an ounce. Request was also made that the government base its taxation on zinc and lead on London quotations instead of quotations in New York, since these products are sold principally in the European markets. Finally, the congress recommended free importation of all articles for use in the mining industry that are not produced or manufactured in Mexico.

In speaking of this meeting of mining men, Genaro P. Garcia, the presiding officer, said:

"The results are most satisfactory. They demonstrate that the mining interests of the republic are working together and trying to solve their problems on technical and economic lines. The President of the republic has shown great interest in our efforts and a special committee was named to inform his Excellency of the work of the congress. I am sure that great benefits will accrue as a direct result of the meeting of mine representatives here and that we will have the hearty support of the government."

■

Gould Operating Bella Oak

H. W. Gould & Company, of San Francisco, has taken over the management of Bella Oak Mines, and is installing a 3x40-ft. Gould rotary furnace. This property is one of the old quicksilver mines of Napa County, having been first operated in 1876. It made a considerable production at that time and also during the War period. The property is a mile west of the highway near Oakville, Calif., and about 25 men are employed.

■

Idaho-Maryland Adds to Mill

Installation of an additional twenty-stamp unit is planned at the Idaho-Maryland Mines property, near Grass Valley, Calif. The flow sheet of the plant will also be revised. A similar increase in capacity was made in 1929, and the plant will now have sixty stamps available. At the Empire-Star mill, owned by Newmont Mining, sixty stamps are in operation. The new cable tramway from the North Star mine to the mill has almost been completed. About 500 to 600 men in all are employed in the mining properties of the Grass Valley area.

Large-Scale Tests to Start on Southwestern Potash

Commercial scale tests of polyhalite from deposits in the Southwest discovered by the U. S. Bureau of Mines will soon begin at the Bureau's experiment station at New Brunswick, N. J. Laboratory tests indicate that the potash content can be recovered at costs that will make it possible to compete with imported potash in all parts of the country except the Eastern seaboard. Private enterprise has already begun operations looking to commercial production. Railroads are studying the rate situation and fertilizer manufacturers are making commitments to use the domestic material within certain price ranges.

The Bureau's explorations in the redbeds area in the Southwest have developed beds of polyhalite as thick as 12 ft. and running as high as 15 per cent K_2O. Though the continuity of individual beds has not been proved, it has been demonstrated that the potash-bearing material underlies the salt over a large area. The potash occurs at depths varying from 500 to 2,000 ft.

If the experiments at New Brunswick indicate that laboratory recoveries can be approximated in commercial practice, the sinking of several shafts by private companies will probably be undertaken. Though the potash material lies at a considerable depth, no difficulties of a mining character are anticipated. The drifts on the polyhalite will be immediately under the rock salt bed, which makes an excellent roof.

■

Ellis Impressed by Size of African Mineral Deposits

South Africa's mineral deposits were impressive to him chiefly for their remarkable size and consistency, E. E. Ellis, president of Universal Exploration, who recently returned from the third Empire Mining Congress, declared at a meeting of the New York section of the A.I.M.E. on May 28. The vastness of the country's resources indicated that the mineralizing forces had been at work over long periods of time, he remarked, citing the chrome, diamond, copper, and gold deposits as instances. Mr. Ellis's address was illustrated by two reels of motion pictures, which he had taken and which belied his modest claims of being only an amateur photographer. The pictures included several remarkable shots of the great Kimberley and Premier diamond pits, pouring gold at the Germiston refinery, and dances of the colored workers at the Rand mines.

In discussing Northern Rhodesia, Mr. Ellis pointed out the splendid sanitation work that is being done by the copper companies and predicted that within two years, or at the most three, Northern Rhodesia would be as healthy a country as the Transvaal. He confirmed reports that labor would be one of the most pressing problems that the mines would have to face. In this connection, he pointed out that the average weight of the colored workers employed in the Belgian Congo was about 123 lb., whereas in the Rand it was about 150 lb. Heavy mine timbers, he declared, would have to be imported from the Pacific coast of the United States, as the local supply is inadequate.

In discussing the gold-mining industry on the Witwatersrand, Mr. Ellis pointed out that the average grade of ore handled is $6.70 a ton, and the average cost about $4.70 a ton, indicating a margin of profit of $2 a ton. But, since mines producing only 40 per cent of the tonnage are responsible for 80 per cent of the profit, the narrow margin on which the lower grade mines operate makes the problem of costs all important. The close watch that is now being kept on the workers in connection with miners' phthisis is an indication that the disease will eventually be checked, Mr. Ellis believes.

Diamond mining came in for its share of attention, the concentrating process now in use at Kimberley and Premier being described in some detail. The ratio of concentration at the former plant is 15,000,000:1 and at the latter, 25,000,000:1, which, Mr. Ellis feels, should make copper mill men sit up and take notice.

■

Los Angeles Miners Organize

A Los Angeles chapter of the California Mining Association was formed at a meeting held at the Engineers Club of Los Angeles on May 16. W. G. Clark was elected chairman; R. A. Church, vice-chairman; and Edgar Bush, secretary. C. L. Gilmore, W. F. Gormley, and C. S. Brooks, state secretary, made addresses at the meeting.

■

Mining Club Opens Quarters

The Mining Club, recently organized as a luncheon club by a group of mining engineers in New York City, opened its new quarters with a buffet luncheon on Tuesday, May 24. A large number of invited guests was present and united in predicting the success of the enterprise. The attractively furnished club rooms are on the third floor of the building occupied by Fusco's restaurant, at 18 Beaver St., near the Cunard Building, on Broadway. They will be open till 4 p.m. daily, under the supervision of a steward, for the use of members and their guests.

■

San Juan Shipments Still High

Notwithstanding low metal prices, production from mines in San Juan County, Colo., has decreased little. Shipments for April were 233 carloads—only 11 carloads below the March shipments. Of this total, Sunnyside shipped 96 cars of zinc concentrates; 78 cars of lead concentrates; and 20 cars of iron concentrates. Shenandoah-Dives shipped 26 cars of concentrates carrying gold, copper, and lead; Colorado-Mexico shipped 10 cars of concentrate; Vertex, 1 car; Altamont, 1 car; and 1 car of ore was shipped by leasers from the Little Nation mine.

■

Empire Chief Cuts Oreshoots

Empire Chief Mining, 14 miles west of Lake City, in Hinsdale County, Colo., has found three separate oreshoots in the main tunnel, which has been driven on the Magnolia vein. This is a primary chalcopyrite ore, carrying gold, silver, and copper. In these shoots the vein varies in width from 18 in. to 5 ft. The orebodies will be developed by raises and winzes to determine their vertical extent. The company owns a new flotation mill fully equipped with a capacity of 200 tons per day. It also owns its own waterpower plant.

California Sections Meet in Yosemite Valley

Northern and southern California sections of the A.I.M.E. held a joint meeting in Yosemite Valley, May 23-25, 1930. The attendance of around 80 was about equally divided between both sections. At the evening meeting H. Norton Johnson presided for southern California and F. W. Varney for northern California. A. B. Parsons, assistant secretary of the Institute, represented the members at large. The southern California section announced the election of new officers: A. B. Menefee, chairman; H. Norton Johnson, vice-chairman; Van Court Warren, secretary; and Glenn D. Robertson, Julian Boyd, and F. L. Ransome, members of the executive committee. Short addresses were made by the chairmen and Mr. Parsons. Mrs. Alexander Anderson and Mrs. James G. Parmelee entertained, and motion picture reels of the visit to Sequoia Park were thrown on the screen.

Mr. Harwell, naturalist of the Yosemite Park service, concluded the evening with an interesting account of the bird life in the park, showing many slides upon the screen and rendering bird songs for the edification and pleasure of all.

On the following day a picnic was held in the park and in the evening the Women's Auxiliary conducted the meeting. Mrs. S. L. Gillan and Mrs. M. L. Latham represented the sections, and Mrs. L. H. Duschak, Mrs. J. G. Parmelee, and Mrs. Alexander Anderson entertained.

■

Lake Superior Men to Hold Annual Safety Meeting

Safety in iron and copper mines will be discussed at the twelfth annual safety conference of the Lake Superior mining section of the National Safety Council, to be held at Duluth, Minn., on June 26 and 27. About 300 mining men are expected to attend the meeting, which will include exhibits of safety devices, equipment, and machinery.

On the program for the first day of the meeting are an address of welcome by E. B. Dunning, of the Duluth Chamber of Commerce; a paper by W. R. Meyers, of Cleveland-Cliffs Iron, on "Standardization, Discipline, and Safety"; "The Fundamentals of Accident Prevention," by C. P. Waite, Travelers Insurance Company; "Safety Practices in Drifting, Raising, and Sinking," by R. C. Mahon, M. A. Hanna Company; "The Effect of Physical Condition of a Metal Miner Upon His Liability to Accident," by Dr. R. R. Sayers, U. S. Bureau of Mines; "Safety Practices in Uses of Electricity Underground," by L. C. Moore, Cleveland-Cliffs Iron; and "School Safety," W. Dean Keefer, National Safety Council. A special safety film, arranged by S. J. Sicotte, of Pickands, Mather & Company, will also be presented. At 6:15, a banquet will be held at the Hotel Duluth.

On June 27, B. D. Shove, Oliver Iron Mining, will speak on "Protective Wearing Apparel," and a discussion of unusual accidents will be led by R. R. Trengrove, M. A. Hanna Company. Following a business session, a boat trip on St. Louis Bay, Lake Superior, will conclude the meeting. Durant Barclay is chairman of the committee in charge and F. S. Crawford is chairman of the program committee.

Tintic Gold Output Rises as Ore Is Found in Quartzite

Development of the Cambrian quartzite formation in the eastern part of the Tintic district, Utah, has resulted in increasing gold production from four mines—Eureka Standard, Tintic Standard, Eureka Lilly, and North Lily. The importance of the discoveries is yet to be fully determined and not enough is known to formulate a geological theory, but a very interesting new field of exploration has been opened.

In the past, with the exception of the Mammoth and a few other mines, properties in the Tintic district have shipped largely silver-lead ores from the limestone formations. Output from the quartzite was negligible. Following the development of the Eureka Standard mine, however, gold-bearing quartz was struck in crosscutting north of the main stope on the 700 level of the North Lily mine. Since this discovery, North Lily has shipped a substantial amount of ore averaging 2.5 per cent lead, $10 in gold, and 2.5 oz. of silver to the ton. The vein has been explored with encouraging results below 700 ft., and the company is now planning development of the crushed quartzite zone on the 1,300 level.

At the Eureka Lilly property, the gold-ore occurrence is almost identical with that in the North Lily, which it adjoins. Ore is found in oxidized form in the quartzite formation below the Ophir limestone, which has been productive of silver-lead ore. The success of this development is vouchsafed by the increase in Chief Consolidated's gold output, of which 90 per cent comes from the Eureka Lilly.

At the Eureka Standard mine, the ore occurrence is similar to that in the North Lily, Eureka Lilly, and a recent find on the 1,400 level of the Tintic Standard mine only in that it is associated with the Cambrian quartzite, for at the Eureka Standard the ore is sulphide, whereas at the other properties it is oxide. Although much study has been focused on the mineral carrying the gold in the Eureka Standard ore, it still remains to be identified. For this reason, very close sampling and assaying must be practiced at the property to maintain the grade of ore shipped. During 1929, the mine produced about 18,000 tons of ore carrying $23 a ton in gold, with some silver. Completion of the new surface plant has permitted doubling of this production rate, and further increases are probable.

■

International Smelting Work at Park City Continued

International Smelting, Utah subsidiary of Anaconda Copper, is continuing development on the acreage it controls at Park City, Utah, although on a somewhat reduced scale because of low metal prices. Sinking of the Park Premier shaft, adjoining Park Utah Consolidated, has been halted at 435 ft. A flow of water was struck at 420 ft. and a shaft station has been cut at 350 ft. to permit pump installation. Eventually the shaft will be continued to 500 ft. and exploration of the limestone area will be undertaken.

In the Victory Tunnel, International Smelting is driving a crosscut through a porphyry breccia formation to reach a fissure in the limestone at a vertical depth of 400 ft. The company is also sinking the Park Konold shaft to a depth of 1,200 ft. to permit prospecting the sedimentary areas, proved to a depth of 1,000 ft. by churn drilling. The shaft is now below 570 ft., having been enlarged to two hoisting compartments and a manway and deepened from 362 ft. It is being sunk on a co-operative basis by Park Konold and Park Nelson, both controlled by International Smelting.

■

Tintic Standard Ends Drilling; Closes Two Small Properties

Churn drilling at the Tintic Standard holdings, near Eureka, Utah, has been completed by the L. W. Prunty Drilling Company, Ponca City, Okla., which did 10,000 ft. of work under contract. Holes as deep as 2,000 ft. were drilled, one near the No. 2 shaft being drilled for use as an emergency pump column. Results are said to have been highly successful. Progress varied from 30 to 87 ft. per twelve-hour shift, depending on the nature of the ground. Diamond drilling will be done on the holdings of E. J. Raddatz, president of Tintic Standard. They are east of the North Standard mine.

Tintic Standard is suspending operations at its Iron Blossom and Colorado properties. When these two mines were acquired, the known orebodies had been virtually depleted. They have since been worked principally under lease, and only small tonnages have been shipped.

■

Atlixtac Plant Resumes

After a shutdown of two years, the 175-ton flotation plant of International Ore & Smelting, at Atlixtac, Guerrero, is running at full capacity on silver-lead-zinc ore. About 250 men are employed at the property. Most of the mines in Guerrero are now closed. The operators claim that freight charges of the railroads, combining with low metal prices, make shipment of any but high-grade ore impossible.

■

Uvada Driving New Tunnel

A new tunnel is being driven by Uvada Copper Mines, near Contact, Elko County, Nev., to cut an orebody on the granite-limestone contact from which small shipments are being made in a higher tunnel. A carload of ore, averaging 10 per cent copper and $2 in gold per ton, was recently shipped to Salt Lake City, according to C. M. Zabriskie, manager of the property. The company is building a bridge to shorten the haul from the mine to the railroad by about 5 miles.

■

Colorado-Mexico Treats Dump

About 40 to 50 tons of material is being trammed to the Iowa mill of Colorado-Mexico Mining from its mine dump, near Silverton, Colo. In addition, about 80 tons of mine ore is being shipped to the mill over the company's cable tramway. Gold and copper are the chief metal contents of the ore, although it also carries some silver and lead. The dump is estimated to contain 30,000 tons of $7 material. About twelve carloads of concentrate is produced monthly.

Saraos Shaft at Fresnillo Reaches 560-M. Level

Sinking of the Saraos shaft, on the Cueva Santa sulphide vein, at the Fresnillo property, Fresnillo, Zacatecas, Mexico, has reached 560 m., the present objective, and a station has been cut preparatory to development work. The 560-m. level will be the main level at Fresnillo after the 425-m. level has been worked out. Intermediate levels will be opened at 470 m. and 515 m. Sinking of the east winze on the Cueva Santa vein has also been started from the 425-m. level, a hoist and headframe having been erected at that depth.

No development work has yet been done below 425 m. on the sulphide veins at Fresnillo, although at that depth silver-lead-zinc ore has been proved on the Santa Cueva vein for more than 1,800 ft., over an average width of about 3.5 ft., and with ore in both east and west faces. Of the total length, only about 725 ft. is in the main oreshoot, which has been proved for 2,145 ft. at the 340-m. level. Indications are that the high-grade western section of this oreshoot has a flat rake to the west at this depth, as the west face is now in sulphide ore of good grade and width. The east oreshoot has opened up very well at 425 m., the total length being more than 1,100 ft., compared with 719 ft. at 340 m. In both oreshoots the grade is about 9.5 per cent lead, 12 per cent zinc, 11 oz. of silver, and 0.3 dwt. of gold to the ton.

Development results on the Plomosa vein between the 105-m. and 340-m. levels continue favorable, although the oreshoot is narrow. The Agripo vein, which carries high-grade silver, with comparatively little lead and zinc, has now been developed for a length of 210 ft., over a width of 2.4 ft.

■

Teziutlan Pushing Work on New Minerva Orebody

Development preparatory to starting production from the new Minerva copper orebody at the Teziutlan property of Mexican Corporation, at La Aurora, Puebla, Mexico, is making rapid progress. Last fall the management estimated that the work would require from one year to eighteen months to complete. Diamond drilling from the 300-m. level, southwest of the Volcan orebody, proved the occurrence of a substantial orebody about 185 ft. below that level. A sufficient tonnage was indicated to warrant sinking of a new shaft.

Work was started last October. Since then the Cometa tunnel on the 160-m. level has been extended about 1,350 ft. to the site of the new shaft, which has been sunk and timbered full-size from the surface to this level, and has been connected through in smaller section to 300 m. Stripping to full size in the lower section is now under way and sinking to 400 m., which will be the present bottom of the shaft, will be resumed.

Earnings at the property have been reduced because of the low price of zinc and the heavy outlay for development of the Minerva orebody. About 5,000 tons of ore is being treated monthly in the flotation plant. No announcement has yet been made as to whether the size of the plant will be increased to handle a larger tonnage when production from the Minerva orebody is started.

Outlook for Porcupine Better; McIntyre Ore Reserves Up

When the value of Kirkland Lake's output exceeded that of Porcupine in March, some Canadian mining men were inclined to believe that it marked another step in the gradual decline of the older camp. April production was $1,561,925, the highest total for the year, however, and considering the fact that Dome—normally a producer of $300,000 monthly—was not in operation, it is considered a very creditable record. Last year, with Dome in operation until October, the monthly average was $1,641,372. The new Dome mill is expected to start operation in October or November.

Publication of the McIntyre-Porcupine report at the end of May disclosed ore reserves at the property of $19,417,400, compared with $16,179,200 on March 31, 1929. In the progress of development operations on the 3,875 level, the deepest level in the mine, only 205 ft. of ore was opened up in 1,150 ft. of drifting, but as the work proceeds on the veins exposed, the management anticipates results equal to the mine average. A total of 6,422 ft. of drifting was done during the last year below the 2,875 level, and 3,597 ft. of ore was opened up. Nothing definite is contained in the report concerning the possibility of an increase in mill capacity. The 200-ton experimental flotation unit has operated with "very satisfactory results," the report states, and this method has been demonstrated as applicable to treatment of McIntyre ores with a reduction in costs and improved metallurgical results.

New ore discoveries of considerable importance have been reported at Hollinger Consolidated. Reports to this effect have been partly confirmed by N. A. Timmins, president of the company, who stated that some new ore has been developed and that diamond drilling had indicated other interesting discoveries. Hollinger is now said to be treating 4,600 tons daily, of an average grade of $7 a ton, from which a monthly production of about $1,000,000 is being obtained. In 1929, the monthly average produced at Hollinger was $780,000.

■

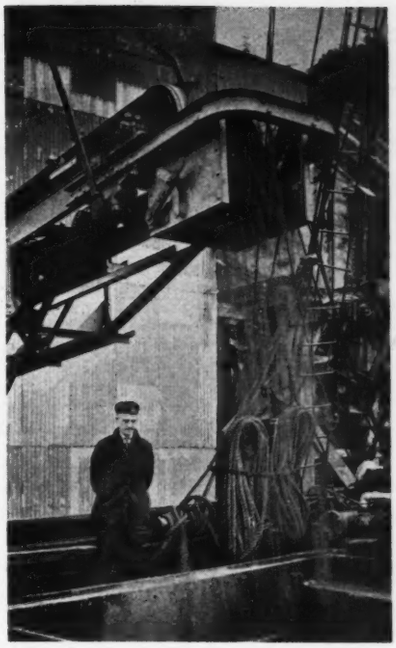
Teck-Hughes to Enlarge Mill

Teck-Hughes Gold will add a 300-ton unit to its cyanide plant at Kirkland Lake, Ont., bringing total capacity up to 1,250 tons daily, directors of the company have decided. The increased capacity will not be fully effective until next year, when operations on tailing re-treatment will have been finished. This will permit using the entire enlarged plant for run-of-mine ore, with a probable average grade of $16 to $18 a ton. Annual production of about $7,000,000 is indicated. The company's program of exploration at depth is proceeding satisfactorily. The main and the south shafts have been connected on the No. 25 level, which is at 3,000 ft., and the hoisting capacity of the mine has therefore been increased.

■

First Cleanup at Howey

The first shipment of gold bullion from Howey Gold, the new producer in the Red Lake district, Ontario, has arrived at Sioux Lookout by airplane. It is said to be about $75,000 in gold. The mill is now handling 400 tons of $7 ore daily.



Loading copper concentrate at Howe Sound's Britannia plant, in British Columbia

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Three Die in Sonora Mine Raid

An attack on the Silver Plume mine, near Cananea, Sonora, Mexico, on June 2 resulted in three deaths, one of those killed being Charles Koehler, said to be an American mining man. The raid is said to have been the result of the closing of the adjoining Manzanal mine. The Silver Plume, a silver-lead property, is owned by Minaret Consolidated. In addition to Mr. Koehler, a mine policeman and one of the raiders died in the fight.

■

May Reopen Gold Area

Attempts are being made by Palmer Development to resume operations in the old Palmer gold field, north Queensland, from which about £5,000,000 in gold has been produced. Little work has been done for the last 30 years, although the district has been known since 1873. Ernest Hunter, a former member of the Australian parliament, is now in England representing the company, which holds options over about 600 acres of ground and a lease for 21 years on the Cooktown-Laura railroad, 68 miles long.

■

Kennedy Starts New Hoist

Kennedy Mining & Milling recently completed the new hoist installation on the main shaft of its gold property, near Jackson, Calif. David McClure, mining engineer, of San Francisco, director of the company and its oldest stockholder, started the new 800-hp. Allis-Chalmers electric hoist, which completes the surface plant erected to replace the old plant, destroyed by fire in 1928. The Kennedy main shaft is 4,764 ft. deep, one of the deepest on the American continent. The hoist used at the main shaft since the fire is being dismantled. It will be installed at the new winze that will be used for operations below the 4,600 level.

Drop in Copper Price Closes Only One Canadian Mine

More than a month and a half has passed since the price of copper dropped, but a survey of operations in eastern Canada shows only one small mine that has suspended completely because of the lower price. Most of the Canadian mines are continuing with their campaigns for new or increased production. The one mine to close was the Amity Copper, in the Boston Creek area, near Kirkland Lake, Ont. The property had shipped some ore to the Noranda smelter.

At the smaller properties in the Rouyn district, development and construction work is being continued. Newbec has cut some additional 7 per cent copper ore on its 125 level and is making shipments of high grade to the Noranda smelter. Aldermac, which has fairly large reserves of low-grade ore, is said to be considering construction of a 500-ton plant. Abana has started work on building its new 250-ton plant. Reserves of ore are sufficient for close to two years of operation without depleting the orebodies predominantly zinc in content. These will be left untouched until a market is available for zinc concentrate. Amulet is continuing production, although a loan of $200,000 had to be negotiated to permit continuation of operations until smelter returns on copper concentrate were received. Zinc concentrate is being stored for shipment when a better market is available.

In the Sudbury district, shipments of ore from the bottom levels of International Nickel's Frood mine have been as high as 5,000 tons daily, and the average daily shipment is now almost 4,000 tons. More than 50 stopes have been opened up in preparation for large-scale production when the new Copper Cliff smelter is blown in, on July 1. Frood ore is comparatively high in copper content, a fact that has been reflected in a very substantial gain in Ontario's copper output, now about 13,000,000 lb. monthly. At the Falconbridge mine, production continues at the rate of about 270 tons of ore daily. One deep diamond-drill hole remains to be completed in the campaign from the 1,000 level. Results to date have been rather disappointing.

■

Opemiska Drilling Progresses

Drilling at Opemiska, 30 miles west of Lake Chibougamau, in Quebec, by Ventures, Ltd., has indicated an interesting copper-gold deposit, although additional drilling and underground work will be necessary to determine its true extent. Eleven drill holes have been put down to date, all of which have intersected No. 1 zone and only one of which has cut No. 2 zone. The holes have been put down at 50-ft. intervals and show average widths ranging from 7.7 ft. to 20 ft. at an average depth of 125 ft. As drilling has progressed eastward on No. 1 zone the grade has increased materially. The one hole to cut No. 2 zone, which is about 300 ft. south of No. 1 zone, cut 9.9 ft. of ore, assaying 17 per cent copper. The two zones have an east-west trend and have been traced for about 800 ft. laterally. Opemiska is about 150 miles from the nearest railhead and was first discovered in the latter part of 1929.

EXCLUSIVE

CABLES

FROM CORRESPONDENTS IN THE PRINCIPAL MINING CENTERS

Further Curtailment Urged to Bolster Falling Tin Price

London, May 24.—Tin is now down to £140 a long ton. Traders in the market are still mystified. With the curtailment program that was adopted by most of the producers early in 1930, they had hoped that a halt would be called in the drop of the price of the metal, which was selling for about £300 a ton three years ago at this time. But either the curtailment has not been as drastic as expected, or consumption has dropped off still further, for the market has shown little tendency to reverse its direction. Suggestions are now being made of still further curtailment. Suspension over week-ends, which is the method used by the Malayan dredging enterprises, is advocated for lode mines as well. Of most interest in the market is the action of Anglo-Oriental in increasing its capital by £250,000. The directors state that certain negotiations are now pending to which they attach considerable importance, although no indication is given as to the nature of the negotiations. The Anglo-Oriental group has been a firm advocate of stabilization, and any action it may take is expected to provide for this eventuality.

. . . . Zinc producers are greatly worried by the present position of affairs, and, despite the recent breakdown of negotiations, they still hope to be able to form an international agreement that will stabilize the price of zinc at a reasonable level. European producers generally are not in favor of an agreement with American producers, who, some of them claim, sell surplus zinc supplies anywhere regardless of the price. The attitude of the German producers, who demand preference in their domestic market and are, in fact, agitating for a tariff to insure that preference, does not make the path to international agreement any smoother.

. . . . At the Mount Isa meeting, Leslie Urquhart stated that Mount Isa is not only destined to be the world's greatest individual producer of lead and, at a later date, of zinc, but also possibly the cheapest producer of lead ever known. Mr. Urquhart has great confidence in the modern treatment methods that will be used at his company's property in Queensland. The provincial government is willing to assist in financing the property to the extent of £500,000 of the new issue of £1,500,000 in convertible debenture 8 per cent stock.

. . . . Three Japanese companies have been formed to hold and operate the properties of the Chosen Corporation in Chosen (Korea). Press reports state that a great Japanese combination is negotiating for the purchase of this property, now probably the most important mine in Chosen. The property is producing about 9,500 tons of ore and £12,500 in bullion monthly. It was originally held under a French mining concession, and the transfer of operations to the three Japanese subsidiaries assures a continuation of the company's title to the properties under favorable conditions.

. . . . The properties of Lena Goldfields at Bodaibo, Siberia, have been closed down. The Soviet government is now reported to be discussing a reorganization of its concessions system for mining properties. At present the only mining concession in operation is the Tetiuhe lead-zinc mine, in Siberia. Withdrawal of Lena Goldfields from Bodaibo is said to threaten with starvation the miners employed at the properties, because of the isolation of the district.

■

Rand Dividend Prospects Good; Klerksdorp Renews Activity

Johannesburg, May 27.—The gold-mining industry of the Transvaal seems at present to be in such a satisfactory position as to encourage predictions that dividend declarations for the present half year will be maintained at their previous high levels. Rand mines declare dividends semi-annually, and the approaching mid-year announcements are awaited with extreme interest. Labor conditions have improved in the last few months. The Rand output for the first quarter of 1930 showed an increase of more than 30,000 oz. of gold over the record for the same period in 1929. As production last year set a new production mark for all time, still another record may be expected this year.

. . . . J. Martin, chairman of the board of directors of City Deep, Ltd., in reviewing the position of his company at its recent annual meeting, declared that the outlook is considerably better, recent development work having shown ore of a much improved grade. The directors are hopeful that the mine will regain a sound position. City Deep has not paid any dividend since one of 5 per cent in 1927, and has been operating at a loss for the last two years. Production was 295,615 oz. in 1929, and the loss was £140,126.

. . . . Active development work is being done in the Klerksdorp district, which occupies an approximately corresponding position in the west, in relation to the Main Reef, that the Heidelberg district occupies to the east. Klerksdorp is about 80 miles from the most westerly producing Rand mine. Systematic diamond drilling has been in progress since the beginning of the year. Many years ago sporadic attempts were made to develop this district, but none of them met with success. The government has been urged to make a thorough geological survey of the area. Particular interest is centered on the revival of the old Commonage Reefs gold mine under substantial financial support.

German Copper Imports to Date in 1930 Half of 1928 Record

Berlin, May 29. — German imports of copper in the period from January to April have been 41,610 metric tons. This compares with 67,725 metric tons in the same period of 1929, and with 82,513 tons in 1928, indicating that consumption is about half of what it was two years ago. After a temporary rush, the copper markets are dull again as a consequence of the accumulation of stocks that are relatively large when compared with the extremely sparse supplies held when copper was at 18c. a pound. Germany's copper-producing capacity has been increased again. The new electrolytic refinery at Wilhelmsburg, near Hamburg, which will have a yearly output of 20,000 metric tons, is expected to be ready for operation in November. Brandeis, Goldschmidt & Company, London metal dealers, own the plant.

. . . . After the acquiring of an interest in Hirsch Kupfer by Union Minière, the announcement that Metallgesellschaft and British Metal are participating jointly in the new Amalgamated Metal Corporation has caused a great deal of interest. Some commentators believe that these two deals indicate a merging of European copper interests to offset the American producers. The real motives of the combinations have been withheld, they say, for fear that still indispensable deliveries of American copper will be cancelled. C. F. Kelley's answer to the European protest concerning the rationing of copper sales at lower prices is said to have provoked antagonism here.

. . . . Stolberg Zinc, which is one of the largest German zinc mining and smelting companies, is closing several of its zinc and lead mines in the Rhine and Harz Mountains districts. The future of the Mansfeld copper mines remains very uncertain unless the Reich makes strenuous efforts to prevent closing. The company has passed its dividend. Beginning in June, the Eisleben properties will be closed by the company, as the workers refuse to accept a 15 per cent salary reduction.

. . . . The agreement of European aluminum producers concerning the proposed invasion of their Japanese and Indian markets by the Aluminum Company of America is reported to have been completed. Pechiney, the most important French aluminum producer, states that the metal is holding its own even with the price of copper at 12c. To meet the new and important competition of magnesium, which is being produced by I. G. Farbenindustrie, German manufacturers, Pechiney is completing a magnesium plant of its own.

. . . . Another attempt to renew the Brussels zinc cartel will be made in June. American participation is said to be assured.

Grade Improving at Lake View; Horseshoe Near Capacity

Kalgoorlie, Western Australia, May 31.—Returns for the month of April indicate a decided improvement in the grade of ore handled at the Lake View & Star plant. A total of 6,157 tons of company ore was treated, with a return of £21,238, or about £3 10s. a ton. This compares with the March returns of 7,137 tons, yielding £18,846, or about £2 10s. a ton. The improvement in grade is attributable to recent high-grade discoveries in the property on the 300 level and at depth.

. . . . The new Golden Horseshoe tailing re-treatment plant is now operating near its full capacity of 40,000 tons monthly. In April the plant treated 33,708 tons of tailing for a profit of £2,580, or 1s. 6d. a ton, which is slightly better than the estimates. The tailing averages 7s. 10d. a ton, and recovery of the gold is about 50 per cent.

. . . . Stripping of the rich surface find made recently at Edjudina, 120 miles northeast of Kalgoorlie, is giving favorable results. A trial crushing of samples from the deposit will be made in June to determine the consistency of the grade.

. . . . After 27 years of operation, the old Ingliston mine, in the Meekatharra district, was closed down in April. Its production had been comparatively small. Enterprise mine, at Kalgoorlie, is continuing development. The lode has been opened up on the 365 and 504 levels, and drilling is being done on the 733 level. The grade of ore indicated is good, and reserves are now estimated at about 60,000 tons.

■

Mount Lyell Will Work New Royal Tharsis Orebody

Melbourne, Australia, May 28.—Development work and diamond drilling on the low-grade Royal Tharsis orebody, at the Mount Lyell property, near Queenstown, Tasmania, has now proved 2,500,000 tons of quartzitic sulphide ore, assaying 2.25 per cent copper, above the level of the new North Mount Lyell tunnel. This is about 1,100 ft. from the surface. The ore is easily amenable to flotation and can be extracted with the tunnel—which affords direct access to the metallurgical works—as the basis of operations. The orebody is 85 ft. wide and 450 ft. long and was mined in the upper levels for siliceous flux during the period when pyritic smelting was used. Operations were then carried to a depth of only 400 ft. The importance of this new addition to Mount Lyell reserves can be judged by the fact that in the last annual report of the company, reserves of ore in the North Mount Lyell mine were estimated at 1,013,600 tons of 5.25 per cent copper and in the Lyell Comstock mine at 600,000 tons of 3.25 per cent copper.

. . . . An estimate of ore in sight in the Jervois Range district, Central Australia, has been made by the consulting engineer of the Hanlon's Reward Company. On its 160-acre lease, he estimates a total of 600,000 tons of ore, some of which is lead ore and some copper ore. The lead ore assays 23 per cent lead and 10 oz. of silver to the ton, and the copper ore assays 12.6 per cent copper and 23 oz. of silver to the ton. Silver-mining operations have already begun. This district was discovered by Thomas Hanlon in June, 1929. It is 210 miles from Alice Springs and even further from the railroad. First reports of its size were later stated to have been exaggerated. Lack of available timber and water will be handicaps in developing the field.

. . . . Placer Development has started testing of 1,500 acres of alluvial ground adjoining the North Bulolo leases in New Guinea. The company has also taken an option on 1¼ miles of the Bulolo river bed, adjoining the southern end of the Bulolo leases and below the site of the new diversion weir. An Australian issue of 476,000 shares of Bulolo Gold Dredging, which will be the operating subsidiary on the original Placer Development area, has been oversubscribed. The company reports that the London, Canadian, and United States issues have also been oversubscribed.

. . . . Camden Mines, Ltd., a new London company, has purchased the Silver Peaks silver-lead property at Yerranderie, New South Wales, for £68,000. Of this, £3,000 has been paid in cash and the remainder will be paid in shares.

■ ■ ■

New Ore Estimates Show Gains at N'Kana and N'Changa

London, May 29.—New estimates of ore reserves have been made for the N'Kana and N'Changa mines in official statements published within the last two weeks. A progress report of Bwana M'Kubwa Copper carries a borehole map of the N'Kana mine. Reserves at this property, including the Mindola orebody, are estimated at 66,000,000 tons, averaging 4.02 per cent. Of this, 59,000,000 tons averages 4.2 per cent, practically all sulphide. Two crosscuts driven from the main hoisting shafts have more than confirmed the width and grade of the orebody as shown in the boreholes. The railroad to N'Kana has now been opened.

. . . . N'Changa Copper has estimated its ore reserves on Dec. 31, 1929, at 2,278,000 tons, averaging 4.21 per cent copper, in the River lode; 8,193,000 tons, averaging 3.74 per cent copper, in the Dambo lode; and 54,170,000 tons, averaging 3.77 per cent copper, in the New Discovery area. This total of 64,641,000 tons compares with the estimate of 31,437,900 tons made a year ago. At the company's annual meeting, the statement was made that construction of a pilot plant will be deferred until sinking of the shafts permits testing of average ore. The N'Changa metallurgical problem promises to be complex because of the mixture of oxide and sulphide ore. H. A. Tobelmann and A. J. McNab, who have had experience in dealing with complex oxide copper ores in the United States, are making a report on metallurgy at N'Changa. James Whitehouse, of the Beatty group of companies, has been elected a director of N'Changa to succeed A. Chester Beatty, who resigned recently because of pressure of other duties. At the mine, two 625-kw. turbo generators are being installed. The railroad to N'Changa is expected to be completed within a year. It will be extended from N'Kana.

. . . . A progress report of Rhodesian Selection Trust states that, in addition to drilling at Chambishi, Baluba, and Luansobe, work consisting of trenching and hand drilling is being undertaken at the Luansobe Extension, South Mokambo, South Mutundu, Mutupa, and South Lufubu properties. This means that the company is working eight grants within the N'Kana concession.

. . . . In the first progress report of Mufulira Mines, data are given on the number of men employed—1,485 colored workers and 216 white men. Construction activities are now on a large scale at the property. Hoists, steam-driven power plants, compressors, and coal-handling equipment are being installed. The foundation for the crushing plant is being excavated. A townsite is being cleared and houses are being built. During the first quarter of 1930, 918 ft. of mine openings and 6,468 ft. of drilling were accomplished. For a future timber supply, 84,700 seedlings were planted at the property.

■

More Bolivian Tin Mines Close; Huanuni Trials Satisfactory

La Paz, Bolivia, May 31. — The continued decline in the price of tin is having its effect on the mining industry in this country. Two more mines have completely suspended operations — Morocacala and Chojnacota. The first is a Chilean-owned mine, with an annual output of about 2,200 tons of concentrate annually. Chojnacota, owned by the Compagnie Générale de Mines en Bolivie, is in the Quimsa Cruz district, near the Caracoles mines of Guggenheim Brothers. Mining was stopped at the property at the end of 1929, but broken ore from a shrinkage stope has been treated in the mill during the last few months.

. . . . Fabulosa Mines Consolidated is preparing to shut down operations at its Milluni unit completely. The Union group will continue to produce about 100 tons of ore daily, however. Compañia Minera de Oruro, which recently merged with Compañia Porvenir de Huanuni, operating the San Jose mine, is shutting down the mill at Alantana, near Poopo, where the Huanuni company formerly treated its ores, and will put the combined output of the two mines through its Machcamarca plant. Even Patiño Mines & Enterprises, largest producer in the world, is rumored to be reducing production at its mines in the Uncia district. The company has recently entered an agreement made by leading British-controlled producers to curtail their production.

. . . . The trial run of the new Huanuni tin dredge, 35 miles southeast of Oruro, has proceeded satisfactorily. This dredge has an annual capacity of 1,400,000 cu.yd.

MARKET AND FINANCIAL NEWS

World's Copper Production Shows Little Change

There was scarcely any change in the world's output of copper during April. The daily rate of production was 4,793 tons, against 4,774 tons in March, according to the American Bureau of Metal Statistics. Contrasted with the figures of a year ago, however, the rate of production shows a decline of 1,768 tons.

Production for April totaled 143,798 tons, against 148,005 tons in March, 196,820 tons in April, 1929, and 146,427 tons in April, 1928.

Production of copper in the first four months of the current year totaled 585,763 tons, against 735,485 tons in the same period last year.

Output of copper during the first four months of the year, by countries, with a comparison, follows:

	January-April 1930	January-April 1929
United States	313,836	413,951
Mexico	19,030	21,512
Canada	30,773	22,976
Chile and Peru	87,491	146,401
Japan	27,920	24,397
Australia	4,116	2,945
Europe (*a*)	50,200	47,100
Africa	41,297	44,203
Elsewhere (*b*)	11,100	12,000
Total	585,763	735,485

(*a*) Incomplete, partly estimated. (*b*) Estimated.

World's production of copper, based on refined copper content of blister, for the months of February, March, and April of the current year, in tons, follows:

	Feb. 1930	March 1930	April 1930
United States	74,094	78,514	76,777
Mexico	4,657	4,876	4,430
Canada	6,750	8,390	7,580
Chile and Peru	21,120	21,367	21,037
Japan	6,362	6,662	7,624
Australia	1,546	1,796	650
Europe (*a*)	12,200	13,100	12,300
Africa	(*c*) 10,300	(*c*) 10,300	(*c*) 10,400
Elsewhere (*b*)	2,600	3,000	3,000
World's total	139,629	148,005	143,798

(*a*) Incomplete; partly estimated. (*b*) Estimated. (*c*) Partly estimated.

Production of copper of the world by months and the daily rate, for 1929 and the first four months of 1930, were as follows:

	1929 Monthly Production	1929 Daily Rate	1930 Monthly Production	1930 Daily Rate
January	178,783	5,767	154,331	4,978
February	167,090	5,968	139,629	4,987
March	192,792	6,219	148,005	4,774
April	196,820	6,561	143,798	4,793
May	192,589	6,213	.....	....
June	174,586	5,820	.....	....
July	174,507	5,629	.....	....
August	173,430	5,595	.....	....
September	174,135	5,805	.....	....
October	175,360	5,657	.....	....
November	170,585	5,636	.....	....
December	165,728	5,346	.....	....

Tonopah Profit Dropped

Net income of Tonopah Mining in 1929 was $208,777, after all additions and charges, except expenditures on outside properties. In 1928, the corresponding figure was $375,683. At the end of 1929, the company's surplus was $2,811,542, compared with $2,768,508 at the end of 1929. The company's assets are valued at $4,077,882, as compared with current liabilities of $266,340 and outstanding capital of $1,000,000. Mining and metallurgical properties have been written down to the salvage value of the equipment, so that no charges are made for either depreciation or depletion. The company's production in 1929 was 16,278 oz. of gold and 1,382,161 oz. of silver from the mill at Tonopah, Nev. Tonnage milled was 66,051, of which 33,483 tons came from the company's mine.

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AHUMADA LEAD, operating a lead mine in Chihuahua, Mexico, reports net loss of $37,931 in the first quarter of 1930, compared with $13,659 in the corresponding period of 1929. Production was 2,815,939 lb. of lead, compared with 2,699,740 lb. of lead in the corresponding period of 1929.

LIBERTY BELL GOLD MINING, which formerly operated property near Telluride, Colo., has made a final distribution of 8.06c. a share to stockholders, and the liquidation of the company is now complete. The company produced ore worth $16,171,089 from its mine and paid stockholders $2,858,694 in dividends.

U. S. Lead Production Reduced in April

In the month of April there was little change in either production or shipments of lead. Production of lead in the United States from domestic ore totaled 55,547 tons during April, against 56,552 tons in March. Stocks on April 1 amounted to 42,469 tons, a slight decrease from the total for the preceding month, according to the American Bureau of Metal Statistics. Shipments held about the same level as in March. The demand for lead by cable makers has been heavy ever since the first of the year. Statistics follow:

	Feb.	March	April
Production:			
From domestic ore (*a*)	54,125	56,552	55,547
Secondary and foreign	6,226	8,600	8,520
Total	60,351	65,152	64,067
Stock at beginning	47,756	43,077	42,469
Total supply	108,107	108,229	106,536
Stock at end	43,077	42,469	42,015
Shipments by difference	65,030	65,760	64,521
Shipments reported	64,249	65,051	64,100

(*a*) Includes small proportion of secondary lead that it is impracticable to separate statistically.

Industrial classification of domestic lead shipments for February, March, and April follows:

	Feb.	March	April
Cable	18,719	19,916	18,675
Ammunition	5,041	6,066	6,143
Tin foil	1,390	1,233	1,614
Batteries	4,967	6,430	6,078
Brass-making	217	132	174
Sundries	2,899	3,410	4,069
Jobbers	655	695	421
Unclassified (*a*)	30,361	27,169	26,926
Total	64,249	65,051	64,100

(*a*) Of the shipments reported as unclassified about one-third go into white lead and about 30 per cent into red lead and litharge. Other important outlets are sheet and pipe, which take about 6,000 tons monthly; and solder and babbitt metal.

To Users of *E. & M. J.* Market Prices and Data

THE semi-monthly *Engineering and Mining Journal* (which you are now reading) carries only a condensed review of important market news and price movements. For buyers and sellers of ores, metals, and minerals who require the latest information every week, we now publish every Wednesday night a weekly—*Metal and Mineral Markets.* Printed at high speed, and in a new compact form for reference use, this new service has received enthusiastic indorsement from readers not requiring the technical contents and field operating news carried in the magazine. *Metal and Mineral Markets* is priced to subscribers in the United States and possessions at $2 yearly; to countries in the Americas, but outside the United States, $5; elsewhere, $10 per annum.

World Conditions in Zinc Remain Unsatisfactory

INTERNATIONAL METAL SERVICE, LTD., LONDON

April proved an even worse period for zinc than any of its predecessors. Low as the quotation for the metal has fallen, there is no one bold enough to say that no further decline is possible. By the end of April the price stood at £16 17s. 6d., a drop of £1 5s. for the month. Present prices for zinc in European markets have not been seen since the beginning of the century.

The figures of metal production for March did not show any evidence of curtailment on the part of those countries making returns, and it is surely a reasonable inference that if there had been any move in this direction by those interests who prefer to suspend publication of their own details for the time being, there would at least have been some rumors to this effect. As consumptive demand does not increase, at least to any marked extent, it is obvious that production even now is in excess of needs, and while this condition prevails it seems certain that lower prices must be faced.

Considerable disappointment has been caused at the failure of the brass-making industry to respond to the stimulus of lower copper prices, though business in this direction may improve in the near future. Export statistics of the leading producing countries indicate that the world-wide slump in the galvanizing industry continues. Now and then a better demand from India for galvanized sheets causes some quickening of interest, but so far the volume of actual business has not been commensurate with such inquiry. In the case of zinc sheets, the scarcity of money on the Continent has tended to restrict new building operations and the call for zinc from this direction has been below normal.

On the other side of the picture there is no definite sign that any effective reduction has taken place in production. Practically no important mines which produce zinc ore alone are working today, but, as has been stressed before, such large quantities of concentrate are won as a byproduct of lead mills that this fact has not yet tended to make any serious inroads on smelters' supplies.

Endeavors are still being made to resuscitate the zinc cartel, and while negotiations continue there is, of course, always the chance that something may turn up in this quarter. In the opinion of most observers, the prospects of accomplishing anything really useful are slender indeed. Like everything else in zinc, there is nothing new to be said about the cartel. To sum up, the outlook is still as gloomy as at any time since last autumn, and the present prospects are for even lower prices in the immediate future.

World stocks of zinc on May 1 are estimated as follows:

	Metric Tons
United States	87,500
Canada, including afloat	4,000
Germany-Poland	19,100
Belgium	11,900
France	2,400
Great Britain	5,900
Other European countries	3,000
Australia, including afloat	4,000
Far East	1,600
Elsewhere	2,000
Total	141,400

World stocks of zinc on April 1 were estimated at 138,400 metric tons. Stocks of Jan. 1 of the current year were estimated at 119,400 tons.

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Zinc Production Shows Slight Drop for April

Production of zinc for all countries except Belgium and Poland during April totaled 98,691 tons, against 105,253 tons in March. In the event that Belgium and Poland are producing zinc at about the same rate as in December, 1929, the last month in which complete statistics were published, world production in April was 133,920 tons, contrasted with 137,988 tons for the month of December of last year.

Zinc statistics for March and April, compiled by the American Bureau of Metal Statistics, in tons, follow:

	March	April
United States	47,573	43,080
Mexico	2,265	2,532
Canada	10,637	9,679
Belgium	(c)	(c)
France	9,655	9,009
Germany (a)	10,276	9,710
Great Britain	5,032	4,656
Italy	1,608	1,553
Netherlands (b)	2,400	2,400
Poland	(c)	(c)
Spain	978	941
Australia	5,277	5,133
Rhodesia	1,852	1,798
Elsewhere (b)	7,700	8,200
Total	105,253	98,691

(a) Includes zinc dust, which amounts to about 300 tons a month. (b) Estimated. (c) Not reported.

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Cerro de Pasco 1929 Profit Unchanged From 1928

Cerro de Pasco Copper Corporation made a profit of $10,253,741, before depreciation or depletion, in 1929, compared with $10,190,867 in 1928. Sales of metals increased from $25,261,249 to $28,656,294. At the end of the year the company's inventory of metals and concentrates was valued at $6,006,350, as compared with $6,736,020 at the end of 1928. The company had current assets of $33,602,937 on Dec. 31, 1929, compared with current liabilities of $3,475,964. Its consolidated surplus account on the same date was $58,337,976, compared with $60,065,204 at the end of 1928. The company produces copper, silver, lead, zinc, and gold from several mining properties in Peru.

English Companies Announce Changes in Capitalization

Three English companies—Mount Isa, Anglo-Oriental Mining, and Consolidated Goldfields of South Africa—have announced important changes in their capital structure. Mount Isa, owning a lead-zinc property in Queensland, Australia, is issuing £1,500,000 in convertible and redeemable debenture stock at par. The issue carries 8 per cent interest. After three years, the debentures may be converted into Mount Isa common stock at the rate of one share of Mount Isa stock, of a par value of £1, for each £1 10s. of debenture held.

Anglo-Oriental Mining is increasing its total capitalization to £1,750,000 by creating 1,000,000 new shares with a par value of 5s. These new shares will be held in reserve pending the completion of negotiations by the directors. The company is chiefly interested in Eastern tin mines.

Consolidated Goldfields of South Africa plans to take over South African Gold Trust, Ltd., and Amalgamated Mining Trust, Ltd., both of which have been managed by Consolidated Goldfields. Shareholders of Amalgamated Mining will receive three Goldfields £1 par common shares for each five £1 par shares of their company and stockholders of South African Gold Trust three Goldfields £1 par common for every four £1 par common of their company and one 6 per cent first cumulative preference £1 par share of Goldfields for each 6 per cent cumulative preference share of their company. If the proposals are accepted, Consolidated Goldfields will issue an additional 748,810 common shares and 500,000 first preference shares.

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Financial Notes

CHIEF CONSOLIDATED MINING, operating silver-lead-gold properties in the Tintic district of Utah, reports a net loss, after including proportion of profit realized by subsidiary companies, of $9,400 in the first quarter of 1930, compared with a net loss of $21,158 in the corresponding period of 1929. Production of all metals except lead was increased.

HECLA MINING, operating a silver-lead property in the Coeur d'Alene district, Idaho, reports net profit of $295,824 in the first quarter of 1930. In the fourth quarter of 1929, the net profit was $345,720. Corresponding figures in the first quarter of 1929 were $493,037 and in the fourth quarter of 1928, $429,282. The declines in the prices of lead and silver are responsible for the decreased profits. Production of ore was 73,636 tons in the first quarter of 1930, and 71,902 tons in the preceding quarter.

Copper Output in 1929 2,104,110 Tons

The year 1929 established a new high mark in world production of copper, the revised statistics of the A.B.M.S. fixing the total at 2,104,110 short tons, against 1,891,610 tons in 1928. In the War period the highest point reached was 1,580,475 tons, for 1917. Last year the United States produced 1,026,348 tons of copper, or 48.7 per cent of the 1929 world output. African production moved up to 161,191 tons, against 141,131 tons in 1928, and 118,670 tons five years ago. Canada was credited with 121,151 tons, which contrasts with 96,634 tons in 1928, and 70,698 tons in 1927.

Statistics of the world's production of copper for 1928 and 1929, computed on the basis of the fine copper content of blister copper, allocated according to countries where the ore originated, are given in tons of 2,000 lb. in the following table:

	1928	1929
United States	935,199	1,026,348
Mexico	72,579	86,759
Canada	96,634	121,151
Cuba	18,869	15,740
Total North America	1,123,281	1,249,998
Bolivia	8,300	7,700
Chile	319,549	348,365
Peru	58,453	59,980
Venezuela	.....	.....
Total South America	386,302	416,045
Austria	3,638	3,856
France	2,203	2,205
Germany	28,109	28,660
Jugoslavia	16,629	23,503
Norway	14,200	16,158
Russia	(a) 22,046	(a) 29,762
Spain and Portugal	54,605	56,660
Sweden	1,000	3,500
Total Europe	142,430	164,304
Japan	75,213	82,281
Other Asia	5,600	8,800
Total Asia	80,813	91,081
Australia	13,244	15,979
Africa	141,131	161,191
Other countries	(a) 4,409	(a) 5,512
Grand totals	1,891,610	2,104,110

(a) Conjectural.

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World Output of Silver Increased in February

According to the American Bureau of Metal Statistics, Mexico produced 12,717,000 oz. of silver in February, a large total in view of the reported general curtailment in output resulting from the low prices for the metal. In January, Mexico was credited with an output of 5,877,000 oz. The Mexican figures were responsible for an upward trend in world production, total output for February amounting to 21,849,000 oz., against 15,284,000 oz. in January, and 20,560,000 oz. in December, 1929. Average monthly world production for 1929 was 18,990,000 oz.

April output of silver in the United States was 4,704,000 oz., against 4,998,000 oz. in March, 5,161,000 oz. in February, and 4,753,000 oz. in January. United States produced 19,616,000 oz. of silver in the first four months of the current year, which compares with 20,444,000 oz. in the same period last year.

Canada produced 1,705,000 oz. of silver during April, against 1,714,000 oz. in March, and 1,225,000 oz. in February.

Peru is credited with an output of 1,467,000 oz. in April, against 1,460,000 in the preceding month.

Australian production for April was 671,000 oz., against 720,000 oz. in March.

Burma produced 611,000 oz. of silver in April, against 607,000 oz. in March.

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Tonopah Mining Plans Partial Liquidation

A special meeting of stockholders of Tonopah Mining Company of Nevada has been called for June 23 to act upon a plan of reorganization and readjustment of capital structure, including reduction of capital stock to $500,000 from $1,000,000, par value being $1; proposed sale and transfer of certain assets of Tonopah Mining Company to the Tonopah Corporation; offering of 100,000 shares of stock of Tonopah Corporation to Tonopah Mining stockholders at $5 a share and use of proceeds to pay stockholders 50c. a share in reduction of capital stock.

In a letter to stockholders outlining the proposal of the directors, W. L. Haehnlen, president, says:

"It has been suggested that a reorganization and reconstruction of the capital structure of the Tonopah Mining Company of Nevada be made to conform more fully to the present status of its affairs. The decline in the price of silver, necessitating the closing of the Tonopah mine, brings us to a realization that the life of the old mine has about come to an end. Certain stockholders feel that they should participate in the cash assets of the company, fearing that they might be disbursed in development of mining properties which would not turn out profitable."

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Polish Zinc Smelter to Close

Giesche Spolka Akcyjna, subsidiary of Anaconda Copper Mining, is closing its zinc smelter at Rozdzien-Scoppinitz, according to a report from Katowice, Poland. With the present low zinc price, only the modern and low-cost plants of the company will continue operation. The Rozdzien plant has a total of 6,400 retorts and a capacity of 91,400 tons of charge annually. In addition to this plant, Giesche Spolka operates a retort zinc smelter at Trzybinia and an electrolytic zinc plant near Scoppinitz. Since the first of the year, Poland has withheld publication of all figures on production of zinc. In December, 1929, the last month for which figures are available, the output was 15,743 tons.

Kennecott, Utah, and Nevada Reduce Dividends

Reductions in the dividend rates of the Kennecott Copper Company and two of its subsidiaries, Utah Copper and Nevada Consolidated Copper, were announced June 2 by the boards of directors of the three companies.

The directors of Kennecott voted a quarterly dividend of 75c. a share, placing the stock on a $3 annual dividend basis, against $5 a share, the former basis. Nevada Consolidated reduced the annual dividend rate to $1.50 from $3 by declaring a quarterly payment of 37½c. a share. Utah Copper declared a quarterly dividend of $2, placing the stock on a $8 yearly basis. compared with $16 previously.

Among the copper companies which have reduced their dividends this year are Inspiration Consolidated, largely owned by Anaconda; Calumet & Arizona, Copper Range, Calumet & Hecla, and Chile Copper. Directors of Greene Cananea Copper recently deferred their meeting to make it conform with that of Anaconda, which controls the former company.

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World Lead Production Down in April

World production of lead during April amounted to 153,663 tons, against 163,814 tons in March. The daily rate of production for April was 5,121 tons, against 5,284 tons in the preceding month, and 5,313 tons in February, according to the American Bureau of Metal Statistics. The daily rate for April of last year was 5,418 tons.

Production statistics for the months of February, March, and April, in tons, follow:

	February	March	April
United States	51,362	56,541	52,074
Canada (a)	11,940	14,851	13,379
Mexico (a)	20,175	23,787	22,748
Peru	1,575	1,712	1,674
Germany	10,793	12,057	10,127
Italy	1,384	1,424	2,762
Poland	4,032	(c) 4,000	(c) 4,000
Spain and Tunis (b)	8,502	8,390	7,517
Australia	14,322	16,380	15,238
Burma	7,672	7,672	7,414
Elsewhere (c)	17,000	17,000	16,700
Total	148,757	163,814	153,633

(a) Total North American production of crude lead is correctly stated, but the distribution by countries is not precise. So far as possible, pig lead produced in the United States from Canadian and Mexican ore is deducted and credited to its country of origin, but production from other foreign ores is not so segregated. (b) Partial. (c) Estimated..

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N'Changa Copper Mines, operating a property west of the N'Kana Concession, in Northern Rhodesia, had total cash resources of £337,958 on Dec. 31, 1929. The total expenditure on equipment and development of the properties to that date had been £391,712, of which £114,241 was spent in 1929. The company has an authorized capital of £1,000,000, of which £900,000 has been issued.

Average Metal Prices for May, 1930

COPPER:	
Electrolytic, refinery	12.756
London Standard Spot	53.159
London Electrolytic Spot	59.545
LEAD:	
New York	5.523
St. Louis	5.408
London Spot	17.795
London Forward	17.861
SILVER:	
New York	40.736
London	18.850
Sterling Exchange	485.724
ZINC:	
St. Louis	4.641
London Spot	16.639
London Forward	17.324
TIN:	
Straits	32.108
London Standard Spot	144.818
QUICKSILVER	117.269
ANTIMONY	7.454
PLATINUM:	
Refined	46.000
Crude	38.000
ALUMINUM 99 Per Cent Plus	24.300

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U. S. Molybdenum Output

Four companies produced molybdenum ore in the United States during 1929, Climax Molybdenum, at Climax, Colo.; the Molybdenum Corporation of America at Sulphur Gulch, near Questa, N. M.; the Southern Copper Mining Company at Helvetia, Ariz.; and the Minerals & Metals Corporation, near Sahuarita, Ariz., according to data collected by the U. S. Bureau of Mines. In 1929, a total of 419,400 short tons of ore was milled, yielding 3,854 tons of concentrates, carrying from 75.40 to 88.33 per cent molybdenum sulphide. In addition, a small tonnage of ore carrying 16 per cent of molybdenum sulphide was produced and sold without milling. The metallic molybdenum content of the concentrates and ore so produced, was 4,020,607 lb., an increase of 17 per cent over 1928. Shipments of concentrates and ore from the mines contained an equivalent of 3,094,648 lb. of elemental molybdenum, valued, more or less arbitrarily, at $2,259,000 at the mines.

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BEDFORD MINES and MCDOUGALL MINES, at one time active operators in northwestern Quebec, have been liquidated under an arrangement with Ventures, Ltd. By disposal of their holdings and assets to Ventures, in return for Sherritt Gordon stock, Bedford shareholders will be given two shares of Sherritt Gordon for every seventeen shares of Bedford held. McDougall shareholders will receive one share of Sherritt Gordon stock for every nine shares of McDougall held.

Demand for Metals Quiet—Tin, Silver and Antimony at New Lows

New York, June 5, 1930.—General quiet characterized all of the metal markets during the last three weeks. Demand for copper, lead and zinc dropped off materially. Prices were steady, however, except for silver, tin and antimony. Tin sold at 30c., the lowest since 1922, when 28¾c. was touched; antimony has dropped to 7⅛c., the lowest since 1923, when the price was 6½c.; and yesterday's price of silver, 34c., pushed the known all-time range in the price of that more or less precious metal one point further south. Metals, however, are in no worse condition than the average of other commodities. Price indexes are continuing to decline, which should result in lower costs unless production curtailments affect overhead too much.

Copper Still 13c.

Though at least one second-hand lot of copper was offered at a concession from the uniform producers' price of 13c., and one consumer reports picking up a small tonnage at a discount of 32½ points, the 13c. price continues to hold on lots sold by first-hands. Business, however, has been decidedly slack both in the domestic and foreign markets, and may well continue so for some weeks, after the immense tonnage booked in May. The export total for that month was a little over 108,000 long tons—a record. Consumers' operations are in some instances more active than during the spring, as in wire, for instance; brass mills, on the other hand, have not increased their operations much, though their order books are in better condition than when the price of copper was 18c. Almost all of the copper now being sold is for prompt shipment, and in some instances consumers are asking to have July purchases shipped this month instead, an accommodation that producers are quite willing to extend.

Zinc Price Holds

Zinc prices continue to waver between 4.60 and 4.65c., St. Louis, the higher price being the general level of quotations, and the lower price obtaining when the seller has the opportunity of getting rid of a good tonnage by quoting an inside price. Stocks of Prime Western grade are not burdensome, and so long as Joplin concentrate prices are what they are, smelters show no indication of being inclined to drop their price of zinc below current levels. Though galvanizers do not speak very optimistically of business, it is probable that they bought more zinc in May than in April, and certainly considerably more than in March or February. High-Grade continues unchanged at a premium of 1c., delivered, over St. Louis prices for Prime Western.

Lead Steady

Buying of lead has been on a reduced scale, attributed largely to the uncertainty in the minds of buyers as to the future course of the market. London prices fluctuated within narrow limits and have been well above parity. Prices here are unchanged at 5.50c., New York, the contract basis of the American Smelting & Refining Company, and 5.40c., St. Louis. A feature in the market is the apparent need for immediate shipment metal, as quite a few buyers requested that their orders be given early attention. May shipments to consumers ran somewhat below this year's average, being slightly under 50,000 tons. Based on business now on the books of producers, consumers will have to come into the market for a good tonnage of June lead.

Tin Sells Down to 30c.

Continued selling pressure in London, based on unfavorable statistics for May and the realization that but little has been accomplished so far in the matter of regulating production, sent prices to new lows for the movement. Straits tin sold as low as 30c. a pound, New York, on June 3 and 4. Some fair buying was reported when the price neared 30c., but as soon as the market steadied the demand dried up. Production is holding at such a rate that another increase in the visible supply of tin is expected for June.

Silver at 34c.

During the last fortnight the silver market recorded another sharp decline, the price touching a new low in London of 15 13/16d. and in New York of 34c. Weakness in China exchange has been the cause of heavy sales of silver from that quarter, with only moderate support from India, but today the price advanced sharply to 36⅛c.

Other Metals

Quotations cover large wholesale lots, f.o.b. New York, unless otherwise specified. London prices are according to latest mail advices.

ALUMINUM—Per lb., 99 per cent plus grades, price of leading interest, 24.30c. Outside market, 99 per cent plus, 24.30c.; 98-99 per cent, 23.90c. London, 98 per cent, quoted at £95 per long ton, less 2 per cent for domestic consumption.

ANTIMONY—Per lb., duty paid: Chinese brands, spot, 7⅛c.; futures, 7c. Cookson's "C" grade, spot, 12⅞c. "C.M.C." grade, spot, 11½c. Chinese needle, lump, 8c. Standard powdered needle, 200 mesh, 10c.

Daily Prices of Metals

May June	Electrolytic Copper	Straits Tin	Lead		Zinc
	Refinery	New York	New York	St. Louis	St. Louis
15	12.55	32.50	5.60	5.45	4.60@4.70
16	12.775	32.125	5.60	5.45	4.60@4.70
17	12.775	32.00	5.60	5.45	4.65
19	12.775	31.75	5.60	5.45	4.60@4.65
20	12.775	31.50	5.50	5.375@5.40	4.60@4.65
21	12.775	32.00@32.125	5.50	5.40	4.60@4.65
Av'ge	12.738	31.990	5.567	5.431	4.638
22	12.775	31.625	5.50	5.40	4.60@4.65
23	12.775	31.375	5.50	5.40	4.65
24	12.775	31.375	5.50	5.40	4.65
26	12.775	31.75	5.50	5.40	4.625@4.65
27	12.775	31.75	5.50	5.40	4.625@4.65
28	12.775	31.25	5.50	5.40	4.625@4.65
Av'ge	12.775	31.521	5.500	5.400	4.640
29	12.775	31.25	5.50	5.40	4.625@4.65
30	.....	.....	Holiday	.....	.....
31	12.775	31.125	5.50	5.40	4.625@4.65
2	12.775	30.75	5.50	5.40	4.60@4.65
3	12.775	30.15	5.50	5.40	4.65
4	12.775	30.25	5.50	5.40	4.65
Av'ge	12.775	30.705	5.500	5.400	4.640

Average prices for calendar week ended May 17, 1930, are: Copper, 12.667c.; Straits tin, 32.521c.; ew York lead, 5.583c.; St. Louis lead, 5.442c.; Zinc, 4.633c.; Silver, 41.083c.

Average prices for calendar week ended May 24, 1930, are: Copper, 12.775c.; Straits tin, 31.615c; New York lead, 5.517c.; St. Louis lead, 5.406c.; Zinc, 4.633c.; Silver, 40.313c.

Average prices for calendar week ended May 31, 1930, are: Copper, 12.775c.; Straits tin, 31.425c. New York lead, 5.500c.; St. Louis lead, 5.400c.; Zinc, 4.638c.; Silver, 38.350c.

London

May June	Copper Standard		Electrolytic	Tin		Lead		Zinc	
	Spot	3 M		Spot	3M	Spot	3M	Spot	3M
15	55¼	55	60	147½	149¼	17⅞	17⅞	16⅜	17
16	54⅜	54¼	60	144⅝	146¾	17¾	17 13/16	16⅜	17⅛
19	53⅞	53⅜	60	143½	145½	17 12/16	17 15/16	16⅜	17⅛
20	53⅞	53¾	60½	141¾	143⅝	17 11/16	17¾	16⅜	17 3/16
21	55	54⅞	60½	143¾	145⅝	17 12/16	17⅞	16¼	17½
22	54⅜	54⅜	60½	142½	144½	17⅞	17 15/16	16⅞	17 9/16
23	54	54	60½	141	143	17 15/16	18 1/16	16⅞	17⅝
26	54¼	54⅛	60½	141⅞	143⅞	18⅛	18⅛	16¾	17½
27	53⅞	53⅞	60½	143¼	145¼	18	18 1/16	16 15/16	17⅝
28	53¾	53¾	60½	141½	143	18	18 1/16	16 13/16	17 7/16
29	53⅞	54	60½	141⅛	143⅛	18	18 1/16	16 13/16	17 7/16
30	54	54	60½	140⅝	142⅝	18	18	16¾	17⅜
2	53¾	53¾	60½	138¾	140⅝	17¾	18	16⅝	17 5/16
3	53¼	53½	60½	136⅞	138¾	17 15/16	18 3/16	16 7/16	17 9/16
4	52⅞	53¼	60½	135	136⅞	17⅞	18 1/16	16⅜	17⅛

Prices for lead and zinc are the official prices for the morning session of the London Metal Exchange; prices for copper and tin are the official closing buyers' prices. All are in pounds sterling per long ton (2.240 lb.).

Silver, Gold, and Sterling Exchange

May	Sterling Exchange 'Checks	Silver New York	Silver London	Gold London	May June	Sterling Exchange "Checks	Silver New York	Silver London	Gold London
15	$4.85 11/16	40¾	19	84s 11½d	26	$4.85⅝	39¼	18¼	84s 11½d
16	4.85 12/16	41⅛	19¼	84s 11½d	27	4.85⅝	39¼	18¼	84s 11½d
17	4.85¾	40¾	19	.....	28	4.85 13/16	38¾	18	84s 11 d
19	4.85¾	40⅝	18¾	84s 11½d	29	4.85¾	37¼	17 7/16	84s 11½d
20	4.85 12/16	40½	18 12/16	84s 11 d	30	Holiday	Holiday	17 9/16	84s 11½d
21	4.85 13/16	40⅛	18⅝	84s 11½d	31	4.85 9/16	37¼	17 7/16	.....
22	4.85 15/16	40¼	18⅝	84s 11½d	2	4.85½	36⅜	17 5/16	84s 11½d
23	4.85¾	40½	18¾	84s 11½d	3	4.85 7/16	35	16 5/16	84s 11½d
24	4.85 11/16	40⅜	18⅝	.....	4	4.85 9/16	34	15 13/16	84s 11½d

Average for week ended May 21: Silver, 40.604c.; Sterling Exchange, $4.85771.
Average for week ended May 28: Silver, 39.688c.; Sterling Exchange, $4.85740.
Average for week ended June 4: Silver, 35.975c.; Sterling Exchange, $4.85563.

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of silver, 999 fine. London silver quotations are in pence per troy ounce of bar silver, basis of 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command one-quarter cent premium.

BISMUTH—Per lb., in ton lots, $1. Smaller lots $1.15 and up. London 4s.

CADMIUM—Per lb., 70@75c. London 3s. 11d.@4s. for prompt.

CHROMIUM—Per lb., 97@98 per cent grade, 95c.@$1.

COBALT — Per lb., f.o.b. Canadian works: Shot or rondelles, 97@98 per cent, $2.50. Contract sales booked at discounts, depending on quantity. Black oxide, 70 per cent, $2.10. London, nominal, 10s. for metal in small lots, 8s. for black oxide; 8s. 10d. for gray.

IRIDIUM—Per oz., $200@$210 for 98 @99 per cent sponge and powder. London, £41 5s.

LITHIUM—Per lb., 98@99 per cent grade in 100-lb. lots, $18.

NICKEL—Per lb., ingot, 35c.; shot 36c.; electrolytic, 35c. (99.90 per cent), for single lots for spot metal. London, per long ton, £170@£175.

PALLADIUM—Per oz., $25@$27; London, £4 15s.

PLATINUM—Official price quoted by the leading interest on small miscellaneous orders for refined metal, per oz., $46. Transactions between dealers and refiners in the outside market are commonly reported at several dollars less.

QUICKSILVER—Per 76-lb. flask, $118 @$120. Trading quiet, but prices are steady. London quiet, with offers at £22 10s.

SELENIUM—Per lb. in 500-lb. lots: Black, powdered, amorphous, 99.5 per cent pure, $2. London, 7s. 8d.@7s. 9d.

TANTALUM—Per kilo: Heavy sheet, chemically pure, $128; bars, $145; tantalum powder, c.p., $69.35.

Metallic Ores

CHROME ORE—Per long ton, f.o.b. Eastern shipping points, Indian and Rhodesian ores, $20 for 46@47 per cent Cr_2O_3 ore, and $24 for 50@51 per cent ore. New Caledonian ore, high-grade, $24.

MANGANESE ORE—Per long-ton unit of Mn, c.i.f. North Atlantic ports, cargo lots. Exclusive of duty: Brazilian, 46@48 per cent Mn, 28c.; Indian, 48@ 50 per cent, 30c. Caucasian, 52@55 per cent, 30c.; Cuban, minimum 47 per cent, 32c.; Chilean, 47 per cent, minimum, 30@31c.

TUNGSTEN ORE—Per short ton unit of WO_3, N. Y.: Wolframite, $13.50, for nearby delivery. Market dull. Bolivian scheelite is quoted at $13.50, June-July shipment. Domestic scheelite, $15, nominal.

Lead and Zinc Concentrate

Joplin, Mo., May 31, 1930

Blende

	Per Ton
High	$33.70
Premium, Prime Western, basis 60 per cent	31.00
Table and flotation, 60 per cent	30.00
Average settling price, all	31.57

Galena

High	$65.45
Basis 80 per cent lead	65.00
Average settling price, all	63.86

METAL STATISTICS

Monthly Average Prices of Metals

Silver

	New York		London Spot		Sterling Exchange	
	1929	1930	1929	1930	1929	1930
January	57.019	45.000	26.257	20.896	484.577	486.447
February	56.210	43.193	25.904	20.008	484.787	485.784
March	56.346	41.654	26.000	19.298	484.776	485.933
April	55.668	42.428	25.738	19.554	484.808	486.019
May	54.125	40.736	25.084	18.850	484.599	485.724
June	52.415	.....	24.258	.....	484.330	.....
July	52.510	.....	24.289	.....	484.560	.....
August	52.579	.....	24.288	.....	484.368	.....
September	51.042	.....	23.708	.....	484.253	.....
October	49.913	.....	23.042	.....	486.392	.....
November	49.615	.....	22.690	.....	487.104	.....
December	48.475	.....	22.258	.....	487.523	.....
Year	52.993	.....	24.460	.....	485.173	.....

New York quotations, cents per ounce troy, 999 fine. London, pence per ounce, sterling silver, 925 fine. Sterling exchange in cents.

Copper

	F.O.B. Refinery		London Spot			
	Electrolytic		Standard		Electrolytic	
	1929	1930	1929	1930	1929	1930
January	16.603	17.775	75.551	71.469	78.602	83.250
February	17.727	17.775	78.228	71.419	83.538	83.500
March	21.257	17.775	89.153	69.202	98.356	83.405
April	19.500	15.621	81.036	62.075	89.405	74.338
May	17.775	12.756	75.026	53.159	83.727	59.545
June	17.775	.....	74.338	.....	84.013	.....
July	17.775	.....	72.152	.....	84.043	.....
August	17.775	.....	73.783	.....	84.250	.....
September	17.775	.....	75.286	.....	84.363	.....
October	17.775	.....	72.815	.....	83.978	.....
November	17.775	.....	69.324	.....	82.202	.....
December	17.775	.....	68.303	.....	82.569	.....
Year	18.107	.....	75.416	.....	84.921	.....

New York quotations, cents per pound. London, pounds sterling per long ton.

Lead

	New York		St. Louis		London			
	1929	1930	1929	1930	1929 Spot	1929 3 Mos.	1930 Spot	1930 3 Mos.
January	6.650	6.250	6.498	6.100	22.111	22.344	21.545	21.571
February	6.853	6.236	6.739	6.086	23.128	23.156	21.188	21.097
March	7.450	5.662	7.348	5.542	25.409	25.591	18.807	18.940
April	7.187	5.537	7.025	5.428	24.783	24.408	18.319	18.363
May	7.000	5.523	6.761	5.408	23.949	23.750	17.795	17.861
June	7.000	.....	6.790	.....	23.694	23.603	.....	.....
July	6.804	.....	6.607	.....	22.810	22.880	.....	.....
August	6.750	.....	6.553	.....	23.185	23.259	.....	.....
September	6.890	.....	6.689	.....	23.557	23.589	.....	.....
October	6.873	.....	6.674	.....	23.226	23.253	.....	.....
November	6.285	.....	6.135	.....	21.622	21.643	.....	.....
December	6.250	.....	6.100	.....	21.472	21.484	.....	.....
Year	6.833	.....	6.660	.....	23.246	23.247	.....	.....

New York and St. Louis quotations, cents per pound. London, pounds sterling per long ton.

Tin

	New York		London	
	1929	1930	1929	1930
	Straits		Spot	
January	49.139	38.851	222.727	175.466
February	49.347	38.676	223.138	173.750
March	48.870	36.798	220.781	164.851
April	45.858	36.077	206.887	162.638
May	43.904	32.108	197.545	144.818
June	44.240	.....	200.206	.....
July	46.281	.....	209.473	.....
August	46.619	.....	209.815	.....
September	45.359	.....	204.863	.....
October	42.290	.....	190.783	.....
November	40.208	.....	180.565	.....
December	39.745	.....	179.419	.....
Year	45.155	.....	203.850	.....

New York quotations, cents per pound. London, pounds sterling per long ton.

Zinc

	St. Louis		London			
	1929	1930	1929 Spot	1929 3 Mos.	1930 Spot	1930 3 Mos.
January	6.350	5.229	26.196	26.233	19.634	20.241
February	6.350	5.180	26.247	26.347	19.209	19.778
March	6.463	4.934	27.050	27.294	18.304	18.810
April	6.658	4.843	26.759	26.613	17.819	18.378
May	6.618	4.641	26.727	26.619	16.639	17.324
June	6.686	.....	26.216	25.984	.....	.....
July	6.766	.....	25.332	25.418	.....	.....
August	6.800	.....	24.896	25.164	.....	.....
September	6.799	.....	24.208	24.688	.....	.....
October	6.740	.....	22.927	23.329	.....	.....
November	6.242	.....	20.851	21.351	.....	.....
December	5.666	.....	20.072	20.672	.....	.....
Year	6.512	.....	24.790	24.976	.....	.....

St. Louis quotations, cents per pound. London pounds sterling per long ton.

Antimony, Quicksilver, and Platinum

	Antimony (a)		Quicksilver (b)		Platinum (c)			
					Refined		Crude	
	New York		New York		New York			
	1929	1930	1929	1930	1929	1930	1929	1930
Jan.	9.558	8.606	119.481	121.192	70.000	61.923	60.000	51.923
Feb.	9.548	8.830	119.818	120.500	70.000	59.909	60.000	51.909
March	9.531	8.236	121.904	118.808	70.000	54.769	60.000	46.769
April	9.462	7.740	122.000	114.000	70.000	46.462	60.000	38.462
May	8.957	7.454	121.154	117.269	68.615	46.000	58.615	38.000
June	8.845	...	120.500	...	68.000	...	58.000	...
July	8.543	...	121.654	...	68.000	...	58.000	...
Aug.	8.778	...	125.111	...	68.000	...	58.000	...
Sept.	8.709	...	124.542	...	66.000	...	56.000	...
Oct.	8.538	...	124.298	...	65.000	...	55.000	...
Nov.	8.583	...	123.323	...	65.000	...	55.000	...
Dec.	8.420	...	121.950	.....	63.240	...	53.240	...
Year	8.956	...	122.145	.....	67.655	...	57.655	...

(a) Antimony quotations in cents per pound, for ordinary brands. (b) Quicksilver in dollars per flask of 76 lb. (c) Platinum in dollars per ounce. Price of crude based on refined platinum content.

Pig Iron[1] and Aluminum

	Bessemer		Basic		No. 2 Foundry		Aluminum	
	1929	1930	1929	1930	1929	1930	1929	1930
Jan.	18.00	19.00	17.50	18.50	17.50	18.50	24.300	24.300
Feb.	18.00	19.00	17.50	18.50	17.50	18.50	24.300	24.300
March	18.19	19.00	17.62	18.50	17.69	18.50	24.300	24.300
April	18.50	19.00	18.00	18.50	18.00	18.50	24.300	24.300
May	18.81	19.00	18.31	18.50	18.31	18.50	24.300	24.300
June	19.00	...	18.50	...	18.50	....	24.300	...
July	19.00	...	18.50	...	18.50	...	24.300	...
Aug.	19.00	...	18.50	...	18.50	....	24.300	.....
Sept.	19.00	...	18.50	.....	18.50	....	24.300	.....
Oct.	19.00	.....	18.50	.....	18.50	....	24.300	...
Nov.	19.00	...	18.50	...	18.50	....	24.300	...
Dec.	19.00	.....	18.50	.....	18.50	.....	24.300	.....
Year	18.71	...	18.20	.....	18.21	....	24.300	.....

Iron in dollars per long ton. Aluminum in cents per pound, 99 per cent grade.

[1]F.o.b. Mahoning and Shenango valley furnaces; freight to Pittsburgh, $1.76

Monthly Crude Copper Output in Short Tons

	1929 Total	1929 Dec.	1930 Jan.	1930 Feb.	1930 March	1930 April
Domestic						
Alaska shipments	21,947	2,275	1,219	1,298	2,109	1,416
Calumet & Arizona	65,246	5,132	4,591	3,665	3,550	3,752
Magma	19,118	1,377	1,168	1,068	1,178	1,309
Miami	29,569	2,609	2,807	2,564	3,081	2,762
Nevada Cons.	133,140	(d)27,543	.....	.....	(d)19,850	.....
Old Dominion (a)	11,172	830	955	843	885	1,045
Phelps Dodge (b)	111,026	8,200	7,188	6,037	6,048	6,034
United Verde Extens.	29,669	2,371	2,223	1,869	1,681	2,047
Utah Copper	148,312	.....	.....	.....	.....	.....
Tennessee Copper	7,870	705	713	659	672	653
Foreign						
Andes Copper	83,718	5,634	4,779	3,699	.....	.....
Braden	88,155	6,766	4,519	4,618	.....	.....
Boleo, Mexico	13,196	(d)3,542	.....	.....	(d)3,537	.....
Bwana M'Kubwa	6,988	598	612	659	556	525
Chile	150,247	8,743	7,492	7,488	.....	.....
Furukawa, Japan	17,767	1,552	1,308	1,604	1,627	.....
Granby Cons., Canada	30,424	2,345	1,985	1,791	1,726	1,891
Howe Sound	21,516	.....	.....	.....	(d)5,876	.....
Messina	(c)7,200	588	641	554	655	576
Mt. Lyell	7,600	624	.....	.....	(d)3,035	.....
Sumitomo, Japan	20,180	1,612	1,396	1,207	.....	.....
Union Miniere, Africa	149,872	.....	.....	.....	.....	.....

(a) Includes Arizona Commercial. (b) Moctezuma is included. (c) Estimated (d) Three months.

Monthly Production of Primary Copper from U. S. Mines and Daily Rate (Short Tons)

	1928		1929		1930	
	Monthly Production	Daily Rate	Monthly Production	Daily Rate	Monthly Production	Daily Rate
January	68,469	2,209	86,324	2,785	67,838	2,188
February	67,423	2,352	84,735	3,026	59,196	2,114
March	70,327	2,269	93,698	3,023	61,216	1,975
April	69,721	2,324	94,902	3,163	60,338	2,011
May	73,729	2,378	93,392	3,013	.....	.....
June	73,224	2,441	82,354	2,745	.....	.....
July	73,426	2,369	79,229	2,556	.....	.....
August	76,952	2,482	78,885	2,545	.....	.....
September	78,341	2,611	79,402	2,647	.....	.....
October	86,480	2,790	82,575	2,664	.....	.....
November	85,382	2,846	75,934	2,531	.....	.....
December	85,677	2,764	74,772	2,412	.....	.....
Total	909,051	.....	1,006,203	.....	248 588	.....
Monthly average	75,754	.....	83,850	.....	.....	.....
Av. of daily rate	.....	2,484	.....	2,757	.....	2,072

Mining Share Prices—Month of May, 1930

Company Name	Metals Produced	Location of Properties	High	Low	Last
NEW YORK STOCK EXCHANGE					
Ahumada Lead	Lead, silver	Mexico	1.00	0.75	0.75
Alaska Juneau	Gold	Alaska	7.25	6.37½	6.50
Am. Metal	Lead, silver, zinc	Various	45¾	39¼	41
Am. Metal pfd	Copper, gold	Various	113	112	112
Am. Sm. & Ref.	Lead, copper, silver	Various	73	65½	72⅜
Am. Sm. & Ref., pfd.	Gold, zinc	Various	140½	138½	139
Am. Zinc, L. & S.	Zinc, lead	Various	11¼	8.00	11
Am. Zinc, L. & S., pfd.	Zinc, lead	Various	70	62½	65
Anaconda	Copper, zinc, silver	Various	63¾	52½	60¾
Andes Copper	Copper, silver	Chile	27½	21½	29½
Butte C. & Z.	Manganese, zinc	Montana	3.25	2.87½	2.87½
Butte & Superior	Zinc, silver	Montana	3.00	2.62½	2.75
Callahan Zinc-Lead	Lead, zinc	Idaho	1.25	1.12½	1.25
Cal. & Arizona	Copper, gold, silver	Arizona	68¾	50	64
Cal. & Hecla	Copper	Michigan	21½	16½	19½
Cerro de Pasco	Copper, silver, lead	Peru	59½	51½	53¾
Dome Mines	Gold	Ontario	8.87½	7.25	8.87½
Federal M. & S.	Lead, zinc, silver	Idaho	150	145	150
Federal M. & S., pfd.	Lead, zinc, silver	Tri-State	100	100	100
Freeport Texas	Sulphur	Texas	48¾	41½	48½
Granby Con	Copper, silver, gold	Brit. Col.	35¼	27	32½
Greene Cananea	Copper, silver, gold	Mexico	87	87	87
Homestake	Gold	So. Dakota	76¾	74½	76½
Howe Sound	Copper, lead, zinc	Various	34½	26½	33½
Inspiration	Copper	Arizona	21½	16½	19½
International Nickel	Nickel, copper	Ontario	35½	30½	33½
Int. Nickel, pfd.	Nickel, copper	Ontario	121½	120	120
Kennecott	Copper, gold, silver	Various	49½	41⅛	48⅛
McIntyre-Porcupine	Gold	Ontario	19¾	18½	19
Magma Copper	Copper, silver, gold	Arizona	38½	32½	35
Miami Copper	Copper	Arizona	23	17	22
Mother Lode	Copper, silver	Alaska	1¾	1½	1½
National Lead	Lead, zinc	Various	151	141½	149
National Lead, pfd. A	Lead, zinc	Various	143	141	141
National Lead, pfd. B	Lead, zinc	Various	118½	117	118
Nevada Con	Copper, gold, silver	Various	23½	17	20⅜
Park Utah Con	Zinc, silver, lead	Utah	3	2⅜	2⅜
Patiño M. & E.	Tin	Bolivia	23	18½	21½
Phelps Dodge	Copper, gold, silver	Various	36	34½	37½
Rand Mines	Gold	Africa	35	35	35
St. Joseph Lead	Lead, zinc, silver	Various	46	41	44
Seneca Copper	Copper	Michigan	2⅜	1⅜	2
Tennessee C. & C.	Copper, su. acid	Tennessee	15	13½	14½
Texas Gulf	Sulphur	Texas	61½	55	60⅛
U. S. S. R. & M.	Silver, gold, lead	Various	29¾	27	27½
U. S. S. R. & M., pfd.	Zinc, copper	Various	50	28¼	28½
Utah Copper	Copper, gold, silver	Utah	.....	.....	190*
Vanadium Corp	Vanadium, ilmenite	Various	133½	87	122
NEW YORK CURB EXCHANGE					
Aluminum Co. of Am.	Aluminum	Various	331½	285	303
Alum. Co. of Am., pfd.	Aluminum	Various	109½	108½	109½
Anglo-Chilean Con	Nitrate	Chile	43⅜	31½	40⅞
Bunker H. & S.	Lead, silver, zinc	Idaho	70	68½	70
Carnegie Metals	Silver, gold	Mexico	.....	.....	7.00*
Con. Coppermines	Copper, gold, silver	Nevada	6.00	5.12½	5.12½
Copper Range	Copper	Michigan	12¼	11½	12½
Cresson Con	Gold	Colorado	0.37½	0.25	0.37½
Cusi Mexicana	Lead, zinc, silver	Mexico	1.62½	1.00	1.37½
Evans-Wallower	Lead, zinc	Various	4.12½	2.75	2.75
Federated Metals	Trading	Various	21¼	19½	21⅞
Hecla Mining	Lead, silver, zinc	Idaho	12½	12½	12½
Hollinger Con	Gold	Ontario	6.87½	6.12½	6.37½
Hudson Bay M. & S.	Copper, zinc	Manitoba	10½	8.87½	9.87½
Iron Cap Copper	Copper, silver, gold	Arizona	2.00	1.75	1.87½
Mayflower Assoc	Holding	Various	69½	61½	69½
Mining Corporation	Silver, lead, zinc	Canada	1.87½	1.62½	1.62½
New Jersey Zinc	Zinc, lead, silver	Various	80	74½	75
Newmont Mining	Holding, copper, gold	Various	120½	108½	119½
N. Y. and Honduras	Silver, gold	Honduras	11	10½	10½
Nipissing	Silver	Ontario	1.50	1.37½	1.50
Noranda Mines	Copper, gold, silver	Quebec	30¾	25½	28¾
Ohio Copper	Copper, lead, gold	Utah	1.00	0.75	0.75
Premier Gold	Silver, gold	Brit. Col.	1.00	0.87½	0.93¾
Quincy	Copper	Michigan	.....	.....	39*
Shattuck Denn	Copper, gold, silver	Arizona	6.37½	5.50	5.87½
So. Am. Gold & Plat.	Platinum, gold	Colombia	1.50	1.37½	1.37½
Teck-Hughes	Gold	Ontario	6.87½	6.37½	6.87½
Tonopah Ex	Silver, gold	Nevada	.....	.....	0.10*
Tonopah Mining	Silver, gold, copper	Various	1.25	0.81½	0.81½
United Eastern	Silver, lead	Mexico	0.06½	0.06½	0.06½
United Verde Ex	Copper, gold, silver	Arizona	12¾	11	11½
United Zinc Sm	Lead, zinc	Tri-State	4.00	4.00	4.00
Utah-Apex	Lead, zinc, copper	Utah	2.75	2.00	2.25
Wenden Copper	Copper, silver	Arizona	0.50	0.25	0.37½
Yukon Gold	Gold	Yukon	0.50	0.31½	0.43¾
BOSTON STOCK EXCHANGE					
Ariz. Comm	Copper, gold, silver	Arizona	1.37½	1.37½	1.37½
East Butte	Copper, gold	Montana	1.25	1.00	1.06½
Isle Royale	Copper	Michigan	9.00	7.50	7.50
Mohawk Mining	Copper	Michigan	37½	30½	34½
Old Dominion	Copper, gold, silver	Arizona	7.00	6.00	6.00
Utah Met. & Tunnel	Copper, lead, gold	Utah	0.60	0.51	0.51
MONTREAL					
Asbestos Corp.	Asbestos	Quebec	2.62½	1.25	1.37½
Asbestos Corp., pfd.	Asbestos	Quebec	12	2.00	2.00
Consolidated M. & S.	Lead, zinc, silver	Canada	225	213	225

Company Name	Metals Produced	Location of Properties	High	Low	Last
TORONTO STANDARD STOCK AND MINING EXCHANGE					
Abana Mines	Copper, zinc, silver	Quebec	0.89	0.50	0.80
Amulet Mines	Copper, zinc, silver	Quebec	0.90	0.65½	0.85
Base Metals	Lead, zinc, silver	Brit. Col.	3.25	2.10	3.00
Barry-Hollinger	Gold	Ontario	0.17	0.13½	0.13½
Canam Metals	Lead, zinc, silver	Various	0.25	0.15	0.17
Castle-Trethewey	Silver	Ontario	0.20	0.17½	0.18
Central Manitoba	Gold	Manitoba	15½	11	0.12½
Coniagas	Holding, silver	Ontario	0.80	0.80	0.80
Falconbridge	Nickel, copper	Ontario	3.80	3.00	3.80
Howey Mines	Gold	Ontario	1.09	0.71	1.00
Keeley	Silver	Ontario	0.36	0.30	0.35
Kirkland Lake	Gold	Ontario	74	57½	72
Lake Shore	Gold	Ontario	23	22¼	22⅛
Sherritt Gordon	Copper, zinc, silver	Manitoba	2.09	1.80	2.05
Siscoe Gold	Gold	Quebec	0.38	0.24	0.33
Sylvanite	Gold	Ontario	0.52	0.50	0.52
Treadwell Yukon	Lead, zinc, silver	Various	6.00	4.25	5.00
Ventures	Holding	Various	1.85	1.13	1.83
Vipond Con	Gold	Ontario	1.40	1.00	1.30
Waite-A.-M.	Copper, zinc, gold	Quebec	2.65	2.25	2.55
Wright-Hargreaves	Gold	Ontario	2.20	1.84	2.18
ST. LOUIS AND CINCINNATI					
Consolidated L. & Z.	Lead, zinc	Tri-State	5.12½	4.00	4.00
Eagle-Picher	Lead, zinc, silver	Various	12½	10	10½
Eagle Picher, pfd.	Lead, zinc, silver	Various	100½	100½	100½
SAN FRANCISCO, LOS ANGELES, AND COLORADO SPRINGS					
California Copper	Copper, gold, silver	California	1.87½	1.75	1.75
Golden Cycle	Gold	Colorado	16½	15	15⅜
Idaho-Maryland	Gold	California	0.36	0.22	0.22
Portland	Gold	Colorado	0.02½	0.01½	0.01⅝
Tom Reed	Gold	Arizona	0.75	0.65	0.68
United Gold	Gold	Colorado	0.09½	0.07	0.08½
SPOKANE					
Constitution	Lead, zinc, silver	Idaho	0.33	0.25	0.29½
Dayrock	Lead, silver	Idaho	2.00	1.75	1.85
Golconda	Lead, zinc, silver	Idaho	0.93	0.74½	0.91
Grandview	Zinc, lead	Wash	0.07½	0.05½	0.07½
Highland-Surprise	Lead, silver	Idaho	.....	.....	0.06*
Jack Waite Con	Lead, zinc, silver	Idaho	0.10½	0.08½	0.09
Lucky Jim	Lead, zinc	Brit. Col.	.....	.....	0.05*
Mexican Premier	Lead, silver, gold	Mexico	0.80	0.50	0.63
Montana Mines	Gold, silver	Montana	0.49½	0.33	0.46½
Noble Five	Lead, zinc	Brit. Col.	0.12	0.09	0.09½
Pend Orielle	Zinc, silver, lead	Wash	1.75	1.00	1.50
Ruth Hope	Lead, silver	Brit. Col.	.....	.....	0.14*
Sherman Lead	Lead, silver	Idaho	0.52½	0.46½	0.49
Silversmith	Lead, silver	Brit. Col.	.....	.....	0.05*
Sunshine Mining	Silver, lead, copper	Idaho	3.10	2.30	2.39
Tamarack & Custer	Lead, silver	Idaho	0.50	0.40	0.42
Whitewater	Lead, silver	Brit. Col.	.....	.....	0.15*
SALT LAKE CITY					
Chief Con	Lead, silver, gold	Utah	1.12½	1.05	1.12½
Combined Metals	Zinc, lead, silver	Various	0.10½	0.10½	0.10½
Eureka Bullion	Lead, silver, gold	Utah	0.25	0.23	0.24½
Eureka Lilly	Lead, silver, gold	Utah	0.58	0.50	0.50
Moscow Silver	Silver, lead	Utah	1.05	0.58	0.80
New Quincy	Lead, silver, zinc	Utah	0.47½	0.35	0.37
North Lily	Lead, silver, gold	Utah	2.00	1.25	1.25
Park Bingham	Lead, zinc, silver	Utah	0.05½	0.03	0.04½
Park City Con	Lead, zinc, silver	Utah	0.50	0.33	0.35
Rico Argentine	Zinc, lead, silver	Colorado	0.11	0.07½	0.10
Silver King Coal	Lead, silver, zinc	Utah	9.30	8.25	9.00
Tintic Lead	Lead, silver, copper	Utah	1.25	1.00	1.12½
Tintic Standard	Lead, gold, silver	Utah	7.00	6.00	6.00
Walker Mining	Copper, gold, silver	California	3.05	2.10	2.70
‡LONDON					
Anglo American	Holding	Various	28/1½	25/—	26/3
Aramayo Mines	Tin, bismuth, silver	Bolivia	36/3	30/7½	31/3
Burma Corporation	Lead, silver, zinc	India	13/9	12/3½	12/10½
Bwana M'Kubwa	Copper	Rhodesia	19/1½	15/7½	18/1½
Camp Bird	Holding	Various	1/1½	—/9d	—/9d
Fresnillo	Silver, lead, zinc	Mexico	12/6	12/6	12/6
Frontino & Bolivia	Gold	Colombia	6/6	6/3	6/6
Lake View & Star	Gold	Australia	12/4½	10/10½	11/10½
Mexican Corporation	Copper, zinc	Mexico	7/—	4/9	6/6
N'Changa Copper	Copper	Rhodesia	90/1½	46/3	81/3
Oroville Dredging	Gold	California	3/1½	1/3	2/9
Rhodes. Congo Border	Copper	Rhodesia	393/9	295/-	385/-
Rhodes.-Select. Trust	Copper	Rhodesia	50/7½	43/1½	48/9
Rio Tinto	Copper, pyrites	Spain	857/6	776/3	810/—
St. John del Rey	Gold	Brazil	19/3	16/3	16/6
San Francisco Mines	Zinc, lead, silver	Mexico	22/—	19/1½	19/6
Santa Gertrudis	Silver, gold	Mexico	10/1½	9/—	9/3
Selukwe	Holding	Africa	4/4½	3/6	3/9
So. American Copper	Copper	Venezuela	2/3	1/6	1/6
Tanganyika	Holding	Africa	42/6	35/4½	39/4½
Wiluna Gold	Gold	Australia	17/9	16/3	17/3
Union Minière	Copper	Bel.Congo	8,300†	7,860†	8,275†

Salt Lake Stock Exchange courtesy J. A. Hogle & Company, Toronto Standard Stock Exchange courtesy the Arthur E. Moysey Company, Spokane Standard Exchange courtesy the Pohlman Investment Company. *Not traded in. †Belgian Francs. ‡The above London quotations are for the month ended May 20.